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The Sixty-Fourth Meeting of the American Astronomical Society

By CURVIN H. GINGRICH

On Wednesday afternoon, September 11, Tower Court on the campus of Wellesley College was the focal point for astronomers and their friends from near and far. Because of the numerous important astronomical centers in the neighborhood of Boston many found it possible to reach Wellesley in an hour or less and many more by leaving home the same day. Some others journeyed a few days, and even a few weeks in a leisurely manner, to be present for the annual September meeting whose sessions were scheduled to continue from Sptember 11 to September 14.

Tower Court, one of the largest dormitories on the campus, was placed at the disposal of those who needed living quarters during the period of the meeting. With its spacious reception and common rooms, its numerous individual rooms, and its beautifully appointed dining room, it was admirably adapted to the purpose. Although when assembled at the sessions the group seemed quite numerous, when distributed on the several floors of the dormitory the population was so sparse that only infrequently would one meet another fellow citizen along the corridors or in the automatic elevators.

As usual all approached the meeting with the anticipation of two or three days of pleasure and good fellowship. Unfortunately this attitude of mind was rudely interrupted for one gentleman and his wife because of the fact that, while stopping in Cambridge for luncheon, their car was broken into and all their luggage stolen. Surprise was expressed and sympathy extended by all who heard of their misfortune, but these were of no avail in restoring their property.

By late afternoon the office was thronging with those awaiting assignment of rooms and eager to be in readiness for the first scheduled event. This was an invitation to tea at the Observatory House at four o'clock, extended by Professor and Mrs. John C. Duncan. By this time a slight shower of rain had set in and consequently cars going from Tower Court to the Observatory House were filled to capacity even though the distance was short and under favorable conditions would have afforded an enjoyable walk along the neat and carefully planned paths and among the trees of the beautiful campus. Those who knew the campus before the hurricane of 1938 lamented the loss of numerous large trees at that time, but those who saw the campus for the first time did not note their

absence and admired those which are left. Upon entering Observatory House and being welcomed there by the host and hostess one quickly forgot the damp conditions outside and felt only the warmth and sincerity of the hospitality. The several rooms resounded with cheery greetings and happy conversation. Here the topics were chiefly social and only secondarily scientific. The group then returned to Tower Court for dinner which was of such a character as still further to convince everyone that the days ahead were to be thoroughly enjoyable ones.

That evening the Council went into its first session and many others availed themselves of the opportunity of returning to Whitin Observatory and inspecting the equipment there. Unfortunately the sky remained clouded and the telescopes could not be put to their principal purpose.

At nine o'clock the next morning the group assembled in the large and very modernly equipped lecture room of Pendleton Hall, the recently built science hall, for the opening session. Dr. Robert G. Aitken, president of the Society, called the meeting to order and presented the president of Wellesley College, Dr. Mildred H. McAfee. In a manner which could not be misunderstood and in phrases whose genuineness could not be doubted, Miss McAfee extended the official welcome of the College. She said that in justifying the purposes of a College she sometimes referred to the "utility of the useless." She implied that somehow this group seemed to her to be the embodiment of the inherent integrity of that phrase! President Aitken responded fittingly expressing what each one felt, namely, that the Society was granted a great privilege in being invited to hold its meeting at Wellesley College.

The president then called upon the secretary to read the names of those members who had died since the meeting one year ago. The Society stood in memory and as a mark of respect while the following eight names were read: Gustavus Wynne Cook, Raymond Smith Dugan, Ferdinand Ellerman, John Churchill Hammond, William Edmund Harper, Wendell Phillips Hoge, Dean Potter, and Herbert Couper Wilson.

This was followed by a few necessary announcements and then the presentation of papers was begun. There were three other sessions for papers at which a total of forty-two papers were read. It is not deemed necessary to summarize or discuss the papers here, since abstracts of all these papers will be published before long in the *Publications of the American Astronomical Society* and will thus be available there for those particularly interested in them. At the conclusion of the morning session the Society photograph was taken. (The photograph was not available at the time of publication of this issue. It will appear as the Frontispiece in the succeeding issue.) The afternoon of this day was devoted to papers. In the evening an informal session was held in the beautiful concert hall in the alumnae building. The group was almost lost in this spacious and beautifully furnished room, but it was selected because of the projection equipment there. During the evening Dr. Orren Mohler, of

the McMath-Hulbert Observatory, explained the method of solar observation there and showed slides of part of the equipment. He also showed a film portraying the movement of solar prominences very realistically. Mr. Charles A. Federer, Jr., of the Hayden Planetarium and editor of *The Sky,* showed a film of the annular eclipse of April 7, taken from an airplane.

On the following morning, Friday, the annual business meeting was held. In calling the meeting to order, President Aitken found the long bamboo pole, which was used for pointing out features on the screen, rather inconvenient to use as a gavel. This experience prompted the suggestion that the secretary be instructed to secure a gavel for use at future meetings. Having Dr. Aitken's recent difficulty clearly in mind, the members voted unanimously in favor of this suggestion. The report of the tellers showed that officers had been elected as follows:

President .....Dr. Joel Stebbins
Vice-President .....Dr. H. R. Morgan
Secretary .....Dr. Dean B. McLaughlin
Treasurer .....Dr. Frank C. Jordan
Councilors—
Dr. Charlotte Moore Sitterly, Dr. J. A. Pearce, Dr. H. M. Jeffers
Nominating Committee—
Dr. E. F. Carpenter, Dr. Dirk Brouwer, Dr. W. J. Eckert

Dr. Dean B. McLaughlin, secretary, announced that the council had acted on the following items:

1. Dr. Antonie Pannekoek was elected an honorary member.

2. The following named persons were elected to membership in the Society, bringing the total membership to 627:

Robert Stanley Alexander, Flower Observatory, Upper Darby, Pennsylvania.
Joseph Ashbrook, Case School of Applied Science, E. Cleveland, Ohio.
Leon Blitzer, Steward Observatory, Tucson, Arizona.
Joseph Canon Boyce, Massachusetts Institute of Technology, Cambridge, Massachusetts.
Esther Raymond Boyd, 220 W. 10th St., New York City.
Edward M. Cook, 66 Highland Ave., Arlington, Massachusetts.
Robert Fleischer, Steward Observatory, Tucson, Arizona.
Katherine Carson Gordon, Goldens Bridge, New York.
David Vance Guthrie, University, Louisiana.
Masaaki Huruhata, Tokyo Observatory, Tokyo, Japan.
Luigi Jacchia, Harvard College Observatory, Cambridge, Massachusetts.
Jean Margaret Rendall, Harvard College Observatory, Cambridge, Massachusetts.
Roderic MacDonald Scott, Harvard College Observatory, Cambridge, Massachusetts.

3. Messrs. Bok, Morgan, and Stokley were appointed a committee for the distribution of astronomical information.

4. The next meeting is to be held at the Franklin Institute and Flower Observatory, Philadelphia, December 30-31, 1940. The meeting following that will be held at Yerkes Observatory, Williams Bay, Wisconsin, next September.

The business session was followed by the address by the retiring president. Dr. Aitken used as his subject, "Comments from the Sidelines." The address elicited much favorable comment.

At the conclusion of the afternoon session Dr. Heber D. Curtis voiced the thanks of the Society for the hospitality afforded by Dr. and Mrs. Duncan, by Wellesley College, and by the Harvard College Observatory in connection with the meeting. The sentiment expressed by Dr. Curtis was heartily and unanimously endorsed.

From five to five-thirty a special carillon recital by Dorothy Birchard Mulroney was presented by the Friends of the Wellesley College Carillon in recognition of the meeting of the Society. This novel feature was greatly enjoyed and appreciated.

At four-thirty o'clock each afternoon tea was served in the lounge at Tower Court. This was a feature which afforded opportunity for visiting and becoming generally acquainted. As a consequence, by the end of the meeting each one knew every one else.

The Society dinner was the final social event of the meeting. The large dining room was filled. After the abundant meal Dr. Aitken called upon Dr. Shapley for a few remarks. Dr. Shapley gave the best interpretation of the cryptic telegram received from Dr. Smiley and Dr. Farnsworth from Brazil. The telegram read, "Being quirk biped Farnsworth Smiley." While Dr. Shapley's interpretation was very ingenious it is quite likely that it will ultimately need revision. Dr. Aitken then, by request, highly entertained the group by recounting experiences connected with the early days on Mount Hamilton. It is interesting to note the contrast from the old to the modern which took place during Dr. Aiken's period of service there.

The formal part of the dinner was concluded at a relatively early hour. But there were the spacious parlors, a piano, and Dr. P. van de Kamp to play the piano. It needed only Dr. Shapley's suggestion that the rugs be rolled back and a dancing floor be thus provided. A number participated in this amusement for a time, after which a request was made for the Virginia Reel. Under the direction of Dr. Shapley and Miss Swope this became the climax and culminating feature of the evening.

On Saturday morning there was a general movement to Oak Ridge, the Harvard College Observatory Station. The morning was spent in inspecting the extensive equipment now assembled here. Perhaps the most interesting feature was the largest Schmidt lens yet made which is now ready to be mounted and put to use. Promptly at 12:30 the luncheon gong sounded and each person was presented with a box lunch through the courtesy and generosity of the Harvard College Observatory. The exercise of walking from building to building gave zest to appetites which resulted in the quick disappearance of the tasty lunches, after which the several parties began their journeys homeward, some extending, as in the case of the writer, over a period of three days.

The meeting at Wellesley College will long be remembered by all the one hundred and forty-five persons who were privileged to be present.

Goodsell Observatory, Carleton College.

List of Stars of the First Magnitude

By PETER VAN DE KAMP

Table I contains information about the twenty-two stars brighter than $1^{M}.6$ on the Harvard visual scale. The parallaxes are of different accuracy. Modern photographic determinations with long-focus instruments, and spectroscopic values have been used; the former have been reduced to absolute by adding a correction for the parallax of the reference stars. One normal trigonometric parallax determination was given weight unity, the spectroscopic values were given weights based on an adopted probable error of one-fifth the parallax value, unit weight corresponding to a probable error of 0".010. The final parallax value represents the weighted mean of the trigonometric and the spectroscopic values; the final probable error has been computed from the total weight. For the stars of large parallax, the trigonometric determinations are therefore of exclusive importance, while the small parallaxes rely, sometimes entirely, but in every case heavily on the spectroscopic determinations. The relative probable error r_d/d of the distance d expressed in light years (1 parsec = 3.26 light years) is equal to the relative probable error r_p/p of the parallax. The superiority of proper motion over apparent magnitude as a distance criterion is clearly shown.—Several stars of the present list are visual double or triple systems. The absolute visual magnitude ($M = m + 5 + 5 \log p$) and the visual luminosity ($\log L = 0.4\,(5 - M)$) for the separate stars are given in Table II. For the very distant stars these are essentially the spectroscopically derived values. Apart from eight companion stars all objects are more luminous than the sun; Rigel is by far the most luminous object. Twenty stars (67%) of Table II are members of seven double and two triple systems, but the physical multiplicity is increased further when spectroscopic binaries are included.

Some well-established features about the individual objects follow.

1 a, b. The binary system Sirius *A, B* has a period of 50 years and a semi-axis major of 7".62. The eccentricity of the orbit is 0.59 and the next periastron passage is in 1944.0. The sum of the masses is found to be 3.2 ⊙, the individual masses are

$$\mathcal{M}_A = 2.2\ \odot,\quad \mathcal{M}_B = 1.0\ \odot.$$

Sirius *B* is a white dwarf.

3 a, b, c. α Centauri *A* and *B* form a binary system with a period of 80 years, and a semi-axis major of 17".7. The eccentricity of the orbit amounts to 0.52; the date of the next periastron passage is 1955.8. The masses are

$$\mathcal{M}_A = 1.1\ \odot,\quad \mathcal{M}_B = 0.9\ \odot.$$

α Centauri *C* is 2° 11′ distant from the center of mass of *A* and *B*, which

TABLE I

No.	Name		1900 R.A. h m	1900 Decl. ° ′	Vis. Mag. M	Spectrum	Annual Proper Motion	Parallax		Distance in light years	
1.	α Canis Majoris	Sirius	6 40.7	−16 35	−1.58	A0	1″.32	″.381 ± ″.004		8.6 ±	.1
2.	α Carinae	Canopus	6 21.7	−52 38	−0.86	F0	.02	.033	4	100	12
3.	α Centauri		14 32.8	−60 25	+0.06	G0, K5	3.68	.761	5	4.28	.03
4.	α Lyrae	Vega	18 33.6	+38 41	0.14	A0	.35	.123	5	27	1
5.	α Aurigae	Capella	5 9.3	+45 54	0.21	G0	.44	.077	4	42	2
6.	α Bootis	Arcturus	14 11.1	+19 42	0.24	K0	2.29	.098	5	33	2
7.	β Orionis	Rigel	5 9.7	− 8 19	0.34	B8p	.01	.006	1	540	90
8.	α Canis Minoris	Procyon	7 34.1	+ 5 29	0.48	F3	1.25	.295	4	11.1	.1
9.	α Eridani	Achernar	1 34.0	−57 45	0.60	B5	.09	.045	6	70	9
10.	β Centauri		13 56.8	−59 53	0.86	B1	.04	.017	2	190	20
11.	α Aquilae	Altair	19 45.9	+ 8 36	0.89	A5	.66	.208	5	15.7	.4
12.	α Orionis	Betelgeuse	5 49.8	+ 7 23	(0.92)	M2	.03	.011	1	300	30
13.	α Crucis		12 21.0	−62 33	1.05	B1	.05	.015	3	220	40
14.	α Tauri	Aldebaran	4 30.2	+16 19	1.06	K5	.20	.062	4	53	3
15.	β Geminorum	Pollux	7 39.2	+28 16	1.21	K0	.62	.114	8	29	2
16.	α Virginis	Spica	13 19.9	−10 38	1.21	B2	.05	.027	3	120	13
17.	α Scorpii	Antares	16 23.3	−26 13	1.22	M	.03	.013	1	250	20
18.	α Piscis Austrini	Fomalhaut	22 52.1	−30 9	1.29	A3	.37	.139	6	23	1
19.	α Cygni	Deneb	20 38.0	+44 55	1.33	A2p	.00	.008	1	400	50
20.	α Leonis	Regulus	10 3.0	+12 27	1.34	B8	.24	.049	4	67	6
21.	β Crucis		12 41.9	−59 9	1.50	B1	.05	.011	2	300	50
22.	α Geminorum	Castor	7 28.2	+32 6	+1.58	A0	.20	.069	4	47	3

TABLE II

	Name	Vis. Mag. M	Spectrum	Parallax		Abs. Vis. Mag. M	Visual luminosity ⊙ = 1
1a	Sirius *A*	— 1.6	A0	″.381 ± ″.004		+ 1.3	30.
b	" *B*	7.1	A5	"	"	+10.0	.0010
2	Canopus	— .9	F0	.033	4	— 3.2	1900.
3a	α Centauri *A*	0.3	G4	.761	5	+ 4.7	1.3
b	" *B*	1.7	K1	"	"	+ 6.1	.36
c	" *C*	11	M	"	"	+15.4	.000069
4	Vega	0.1	A0	.123	5	+ .5	63.
5a	Capella *A*	0.2	G0	.077	4	— .4	150.
b	" *H*	10.0	M	"	"	+ 9.4	.017
6	Arcturus	0.2	K0	.098	5	+ .2	83.
7	Rigel	0.3	B8p	.006	1	— 5.8	21000.
8a	Procyon *A*	0.5	F3	.295	4	+ 2.9	6.9
b	" *B*	10.8	..	"	"	+13.2	.00052
9	Achernar	0.6	B5	.045	6	— 1.1	280.
10	β Centauri	0.9	B1	.017	2	— 2.9	1400.
11	Altair	0.9	A5	.208	5	+ 2.5	10.0
12	Betelgeuse	(0.9)	M2	.011	1	(— 3.9)	(3600.)
13a	α Crucis *A*	1.4	B1	.015	3	— 2.7	1200.
b	" *B*	1.9	B1	"	"	— 2.2	760.
14a	Aldebaran *A*	1.1	K5	.062	4	+ .1	91.
b	" *B*	13	..	"	"	+12.0	.0016
15	Pollux	1.2	K0	.114	8	+ 1.5	25.
16	Spica	1.2	B2	.027	3	— 1.6	440.
17a	Antares *A*	1.2	M1	.013	1	— 3.2	1900.
b	" *B*	5.2	B4	"	"	+ .8	48.
18	Fomalhaut	1.3	A3	.139	6	+ 2.0	16.
19	Deneb	1.3	A2p	.008	1	— 4.2	4800.
20a	Regulus *A*	1.3	B8	.049	4	— .3	130.
b	" *B*	7.6	K2	"	"	+ 6.0	.40
21	β Crucis	1.5	B1	.011	2	— 3.3	2100.
22a	Castor *A*	2.0	A0	.069	4	+ 1.2	33.
b	" *B*	2.8	A0	"	"	+ 2.0	16.
c	" *C*	9.0	M	"	"	+ 8.2	.052

corresponds to a projected linear distance of over 10,000 astronomical units. The period of *C* and *AB* is of the order of a million years.

5 a, b. Capella is a spectroscopic binary whose orbit has a period of 104 days and a negligible eccentricity; interferometer measures give a semi-axis major of 0″.054. Capella *H* has a twelfth magnitude companion at a distance of about 1″.8.

6. Interferometer measures give an apparent diameter of 0″.02 for Arcturus, or a linear diameter of 1/5 astronomical unit.

7. Rigel is a spectroscopic binary with a period of 22 days.

8 a, b. The period of the Procyon system is 40.2 years, the semi-axis major is 4″.26. The eccentricity of the orbit is 0.31, the date of the last

periastron passage was 1926.7. The masses are

$$\mathcal{M}_A = 1.4\ \odot,\ \mathcal{M}_B = 0.4\ \odot.$$

12. Betelgeuse is a semi-regular variable star with a period of 2070 days: the brightness fluctuates between $0^M.1$ and $1^M.3$. Interferometer measurements give an apparent diameter of 0″.04, which corresponds to a linear diameter of about four astronomical units!

13 a, b. The orbital motion of α Crucis is very slow. The yearly decrease in position angle is about 0°.03, that in distance about 0″.008. The present separation is 4″.5. Both *A* and *B* are spectroscopic binaries whose periods are uncertain.

14 a, b. The faint companion of Aldebaran is at a distance of 31″, which corresponds to a projected linear separation of 5,000 astronomical units. Interferometer measures of Aldebaran give an apparent diameter of 0″.02 or a linear diameter of 1/3 astronomical unit.

16. Spica is a spectroscopic binary with a period of 4.01 days.

17 a, b. Interferometer measures give an apparent diameter of 0″.040 for Antares, which corresponds to a linear diameter of about three astronomical units. The companion of Antares is at a distance of 3″.

20 b. The companion of Regulus is at a distance of 176″, which corresponds to a projected linear distance of about 3,600 astronomical units. Regulus *B* has a companion (*C*) of the thirteenth magnitude at a distance of 3″.

22 a, b, c. Castor is known to be at least a sextuple star. The *A, B* system has a period of 380 years and a semi-axis major of 5″.94. The eccentricity of the orbit is 0.36; the next periastron passage is in 1968. The sum of the masses is 4.4 ⊙. Both *A* and *B* are spectroscopic binaries with periods of 9.21 and 2.93 days, respectively. Castor *C* is an eclipsing spectroscopic binary with a period of 0.814 days. The radius of the orbit is only 2,700,000 kilometers, the radius of each component is 430,000 kilometers, each mass 0.6 ⊙. The distance of Castor *C* to the *A, B* system is 73″, which corresponds to a projected linear separation of about 1,000 astronomical units; a small relative motion is observed.

SPROUL OBSERVATORY, SWARTHMORE COLLEGE,
SWARTHMORE, PENNSYLVANIA, 1940 APRIL 16.

Transit of Mercury, November 11, 1940

By J. F. HELLWEG, *Superintendent*

Observations of the transit of Mercury over the sun's disk on November 11, 1940, will be of considerable scientific value, both for the determination of the elements of Mercury's orbit and also for checking the irregularities of the earth's rotation. These transits occur seldom. There will be only nine during the remainder of the present century, four of which will be of very little value due to their short duration.

The transit of November 11, 1940, will be more favorable than any previous one in this century, but not quite so favorable as will be that of 1973. It is therefore of vital importance that the transit of November 11, 1940, be observed by as many observers as possible. By calling early attention to the particular importance of the coming transit of Mercury and by requesting coöperation it is hoped that the efforts of many astronomers can be enlisted.

The results of previous transits have always suffered from the too small number of observations obtained. Only sixteen transits have been observed in the past with the precision comparable to that sought today.

Unless special attention is called to the importance and feasibility of observing the coming transit, it is more than probable that the transit of November 11, 1940, will be very poorly observed. The ingress will be visible over most of North and South America and Australia. But the egress must be observed principally in Australia. No part of the transit can be observed in Europe, Africa, or most of Asia. It is therefore doubly important that the astronomers, both professional and amateur, who are so situated that they can observe this transit should be urged to make definite plans to observe and to allow nothing within their control to interfere with their observations. Of course, bad weather will prevent proper seeing.

Experienced observers are not necessary for this type of observation. It is only necessary that the observer knows what to look for. Any educated person can secure an observation of value if he has a telescope, a page of instructions "what to do," and knows his time accurately to within one or two seconds. Most of the uncertainty in observations is due to atmospheric conditions and this uncertainty can be reduced only by multiplying the number of observations.

Instructions for Observers

Introduction. It is now well established that the rotation of the earth on its axis is not uniform, but varies in an irregular manner which cannot be predicted in advance. That is, our standard of time, which is the period of rotation of the earth, must be checked frequently against the motions of other bodies so that we can correct for its error and obtain a more uniform system of time measurement. One of the most valuable checks is furnished by observations of transits of Mercury across the face of the sun. Such observations also furnish information regarding the motion of Mercury itself, a problem which cannot yet be regarded as completely solved.

Instruments. Observers must be supplied with telescopes and auxiliary equipment of a type suitable for observing sunspots. Refracting telescopes should probably be of at least three inches aperture and reflecting telescopes five inches. The magnifying power should probably be 100-200. The most satisfactory eyepiece is of the prismatic or Herschelian type, which disperses most of the sun's heat. Failing this, a

dark glass may be placed before the usual eyepiece. If a dark glass is used with the larger telescopes some trouble may be had with breakage from the heat. Care should be taken to avoid injury to the eye in such cases. It may be necessary to reduce the aperture with a diaphragm, but this should be avoided if possible. If a prismatic eyepiece or a dark glass cannot be used, the sun's image may be projected on a white screen. Observers not in the habit of observing sunspots are advised to allow considerable time for practice and experiment before the day of the transit.

The Phenomenon. There are four instants when the disks of Mercury and the sun are tangent to each other. The instants of external tangency are known as contacts I and IV. The instants of internal tangency are contacts II and III. The object of the observation is to determine the time of one or more of these contacts. Contacts I and IV are very uncertain and observations of them are of little value. Observers are advised to concentrate on contacts II and III. Of these, only contact II can be observed in America.

The effect of irradiation produces an optical phenomenon known as the "black drop." The sequence of events is as follows. At the time of contact I Mercury begins to impinge on the sun's disk. Its apparent diameter is nearly 10 seconds of arc, or about 1/200 that of the sun. About a minute and a half later will occur a phenomenon which may be mistaken for contact II. At this instant Mercury appears to be internally tangent to the sun's limb, but light is not yet visible all the way around the planet. This is *not* the time of contact II. About this time the black drop usually begins to form and ten seconds later Mercury will appear as a black drop hanging on the sun's limb. Several seconds later the black drop will break away from the sun's limb and this is the time of true contact II. At this instant a thread of light becomes visible between the planet and the sun's limb. Although this phenomenon is perfectly well defined. the time of its occurrence is often uncertain by more than ten seconds. The boiling of the sun's limb, particularly when low in the sky, makes the observation difficult. Sometimes the thread of light appears to be made and broken several times in quick succession. In such cases the interval when it was being made and broken is to be noted. In rare instances no black drop may be noticed.

Five hours later, a similar sequence of events takes place in reverse order as Mercury passes off the sun's disk. Here the phenomenon to be observed is the breaking of the thread of light between Mercury and the sun's limb.

The Correct Time. Observers should be provided with a source of standard time accurate to a second or two. A first class pocket watch will serve if a pendulum clock with seconds hand is not available. Synchronous electric clocks should not be used. The clock or watch should be compared with an accurate radio time signal for several days before

and after the transit. Do not attempt to have the timepiece correct but simply keep a record of its error from day to day. The radio time signals broadcast from the Naval Observatory at noon, Eastern Standard Time, over National Broadcasting Company stations are recommended for American observers. Time signals at other hours are available to those possessing short wave receivers suitable for continuous wave reception. A schedule may be obtained from the Naval Observatory.

The use of stop watches is not recommended but if a stop watch is used, it should be compared with a clock whose error is known within a few minutes of the observation.

If a pocket watch is used, it should be kept stationary in the same position for several days before and after the transit, and wound at the same time each day. Observers are advised to test the performance of timepieces carefully before using, and to satisfy themselves that the rate is sufficiently good.

Timing the Observation. The observer is advised to employ the services of an assistant. The assistant should fix his attention on the timepiece and count the seconds aloud, from the time of first contact until second contact is past, and again before third contact. The observer need only listen to the count and note the time of contact mentally.

If a special radio time signal is available, the assistant should count the signals. In the Naval Observatory time signal code, second 29 of each minute is omitted, and also seconds 56 to 59 inclusive, the first signal after the interval corresponding to the zero second of a minute.

Any uncertainties in the time of observation should be carefully noted. Do not attempt to improve the observation after it is made, by estimation of errors. Such notes as the following are very useful. "Contact certainly past." "Doubtful by 20 seconds." "Probably 10 seconds late." "May be one minute in error."

Observers and assistants are advised to practice timing occultations of stars by the moon and other phenomena previous to the day of transit.

Geographical Position. It is necessary that the observer's postion should be known accurately. Topographic maps of the U. S. Geological Survey furnish one of the best methods for this purpose in the United States. Pilot charts will be equally good for places near the coast. The name of a small town, the distance and direction from a railway station, the location relative to high points of land, rivers, bench marks of the Coast and Geodetic Survey and others, all constitute useful information.

Transmission of Results. Observers are requested to transmit their results to the Superintendent, U. S. Naval Observatory, Washington, D. C., U. S. A., where they will be reduced and prepared for publication. Complete information should be furnished regarding all details of the work. Such information should include:

1. Name and address of observer and assistant.
2. Size and type of telescope, including aperture of objective, aperture ac-

tually used, and focal length.

3. Magnifying power or size of sun's image, if projected on a screen.
4. Type of eyepiece and focal length, if known.
5. Atmospheric conditions, clouds, etc.
6. A topographic map or pilot chart if possible, with the observer's position clearly marked thereon. If this is not possible, information which will enable the Naval Observatory to determine the observer's position.
7. Method of timing the observations.
8. Kind and type of timepieces used.
9. Record of performance of timepieces.
10. Source of correct time used as standard.
11. The time of the observation given in standard zone time of the place of observation, that is, Central Standard, Pacific Standard, Central Australian Standard, etc.

Photographic Observations. Observers having telescopes of 10-foot focal length, or more, may use photography. Tests should be made in advance on small sunspots, and the question of halation looked into. Such observations should consist of a series of photographs made at short intervals (less than 5 seconds apart) and the time of contact should be included in the series. Also a series with Mercury near the limb and with the complete image of the sun. The picture must be large enough, without enlargement, to show Mercury distinctly. The time of each exposure must be known accurately. Original negatives may be transmitted to the Naval Observatory. They will be returned if desired.

Circumstances of the Transit. The following table gives the approximate Universal Time (Greenwich Civil Time) of contacts I and III for various regions on the earth.

Region	Contact I		Contact III		
	h	m		h	m
South America	Nov. 11	20 48.7			
North America (Eastern)		20 48.9			
North America (Western) except Alaska		20 49.4			
Alaska and Hawaii		20 49.4	Nov. 12	1	52.2
Australia and New Zealand		20 49.8		1	52.0
Eastern Asia		20 50.0		1	52.8

For any particular location, these times may be in error by several tenths of a minute. Observers should allow ample time for such errors.

For Eastern Standard Time ..... Subtract 5 hours
For Central Standard Time ..... Subtract 6 hours
For Mountain Standard Time ..... Subtract 7 hours
For Pacific Standard Time ..... Subtract 8 hours
For New Zealand Standard Time ..... Add 11 hours 30 minutes
For Eastern Australia Standard Time ..... Add 10 hours
For Central Australia Standard Time ..... Add 9 hours 30 minutes
For Western Australia Standard Time ..... Add 8 hours

The hours given above are reckoned from 0 to 24. To convert to ordinary civil time call the time A.M. if between 0 and 12 hours. Subtract 12 hours and call the result P.M. for times between 12 and 24 hours.

Contact II will occur about 1.8 minutes after Contact I.

Contact IV will occur about 1.8 minutes after Contact III.

The ingress will take place practically at the easternmost point of the

sun's disk, and the egress nearly at the northwest point. The easternmost point may be found in the telescope by allowing the sun to drift across the field. The rearward edge is the point in question.

NAVY DEPARTMENT, U. S. NAVAL OBSERVATORY,
WASHINGTON, D. C., JULY 6, 1940.

An Unusual Conjunction

By WILLARD H. GARRETT

About two hours after sunset early in October, a conspicuous pair of planets may be seen rising in the east. The brighter one is Jupiter; near it is Saturn. Both are in the constellation Aries, a region devoid of bright stars. A month later, November 3, they will be at opposition, rising at sunset and remaining above the horizon all night long.

A little more than ten years ago, a paper[1], read by the writer before the Kansas Section of the Mathematical Association of America, began as follows:

> "An observer of the heavens in 1940-41 is promised a celestial phenomenon of rare occurrence. For a period of more than six months the giant planets Jupiter and Saturn will be grouped together within an area not much more than a degree square. First Jupiter will overtake and pass Saturn; then, as both retrograde, Saturn will appear to overtake and pass Jupiter, and finally, when their direct motions begin again, Jupiter will again overtake and pass Saturn, this time leaving Saturn far behind in a race which for a time seemed so uncertain as to outcome."

The dates predicted for these three conjunctions in geocentric ecliptic coördinates were: August 7, October 20, 1940, and February 15, 1941. In equatorial coördinates the dates were August 15, October 12, 1940, and February 20, 1941.

The calculation resulting in the above prediction was made by the writer while a member of the 1929 summer staff of Yerkes Observatory. He was asked by the director, Dr. Edwin B. Frost, to look into a question which had recently been received from an inquiring correspondent. The question was: "When were Jupiter and Saturn last in geocentric conjunction, and when will the next conjunction take place?"

To find the answer to the first part of the question, a search was made through the files of the *American Ephemeris*. The date of the last geocentric conjunction was found to be September 14, 1921.

Before attempting to find the date of the next geocentric conjunction, it was advisable first to find the date of the next heliocentric conjunction. Since Jupiter's period of revolution is 11.862 years and Saturn's period is 29.457 years, it is evident that in one year Jupiter will make about 1/12th of a revolution and Saturn about 1/30th. The difference is 1/20th so that once about every twenty years there will be a heliocentric

[1] "A Triple Conjunction of Jupiter and Saturn." Topeka, February 15, 1930.

conjunction of Jupiter and Saturn. Using the more nearly exact periods given above, the interval is found to be 19.86 years or 19 years and 314 days.

Consulting the *American Ephemeris* again, the dates of the last four heliocentric conjunctions were found to be: December 28, 1861; April 13, 1881; September 28, 1901; August 22, 1921. The intervals between these dates are: 19 years, 106 days; 20 years, 168 days; 19 years, 328 days.

This shows a rather large variation in the intervals of the heliocentric conjunctions, but there is a reason. It is due to the following unique situation: Five times the period of Jupiter is only a little more than twice the period of Saturn. Hence the planets will be in about the same positions in their orbits at every third conjunction. Such a relationship produces the well-known long-period inequality of Jupiter and Saturn. It displaces Jupiter by as much as 21 minutes in longitude and Saturn by 49 minutes.[2]

This means that while the intervals between the times of consecutive conjunctions may vary greatly, the interval between the first and fourth conjunctions will be nearly the same. Three times the interval of 19.86 years amounts to 59.58 years or 21,760 days. Adding this number of days to the date of the heliocentric conjunction of April 13, 1881, gives November 10, 1940, as the approximate date of the next heliocentric conjunction of Jupiter and Saturn. (Exact computation later fixed this date as November 15, 1940.)

The next step in the procedure was to find the exact heliocentric positions of Jupiter and Saturn at two dates a few days on each side of November 10. For this purpose it was necessary to have recourse to the rather formidable tables of Jupiter and Saturn, Parts I and II of Volume VII of the *Astronomical Papers of the American Ephemeris*, by George W. Hill.

Before going into the results secured by the application of these tables, it may be of interest to review briefly the story of the development of the theory of the motions of Jupiter and Saturn.

As stated in a previous paragraph, the near commensurability of five revolutions of Jupiter and two revolutions of Saturn produces very large perturbations in the motions of the two planets. All during the seventeenth century, Jupiter was getting ahead of its calculated position and Saturn was falling behind. That is, Jupiter's year was getting shorter and Saturn's year longer. In the eighteenth century the reverse took place. For a long time astronomers were baffled in their attempts to explain this situation. Some even regarded it as irreconcilable with the law of gravitation. Finally in 1786 Laplace pointed out the cause of the perturbations and, by his powerful methods of analysis, laid the foundations for the mastery of the planetary perturbations. Tables

[2] Herschel: "Outlines of Astronomy," Section 723.

based on these theories were soon constructed and proved far superior in accuracy to any previously used.

During the nineteenth century many notable contributions were made to the planetary theory. In particular Leverrier and Hansen developed methods and tables for computing the positions of Jupiter and Saturn that were in general use during the latter part of the nineteenth century. These, however, failed to completely overcome the difficulties associated with the long-period inequalities in the motions of these planets, and after a few years the predicted positions and the observed positions failed to agree.

In 1877, Simon Newcomb took charge of the Nautical Almanac office. The need of better tables was evident. Impressed by the ability of George W. Hill, a computer in the Nautical Almanac office, Newcomb intrusted the construction of a new set of tables of Jupiter and Saturn entirely to him. It was a prodigious task. After ten years of incessant labor, during which he scarcely took time to eat or sleep, Hill carried through the most abstruse and complicated of mathematical calculations and in 1890 the manuscript of what now forms Volume IV of the *Astronomical Papers of the American Ephemeris,* "A New Theory of Jupiter and Saturn," was finished. This was followed in 1895 by 139 tables for computing the ephemerides of Jupiter and Saturn, forming Parts I and II of Volume VII of the same series. Since 1900 these tables have been used in the construction of most of the leading ephemerides. They will remain for many years a monument to the man, who, in the judgment of Simon Newcomb, will easily rank as the greatest master of mathematical astronomy during the last quarter of the nineteenth century.

When one considers that during this time Mr. Hill received an annual salary of only $1200 which Mr. Newcomb with great difficulty succeeded in inducing the Secretary of the Navy to raise to $1400, it offers a sad commentary on the way our government recognizes and rewards genuine worth. And it was a foreign university that first gave academic recognition to Mr. Hill. In 1892 Cambridge University, England, conferred on him the degree of Sc.D. Later he received the degree of LL.D. from Columbia and Princeton.

By the use of Hill's tables, of which 68 are of Jupiter and 71 of Saturn, the writer computed the heliocentric longitudes of Jupiter and Saturn for November 6 and 16, 1940. By interpolation the time of the heliocentric conjunction was found to be November 15. Since the longitude of the Earth on this date was only a little more than nine degrees greater than that of the planets, it seemed probable that, instead of one conjunction of the planets as viewed from the Earth, there might be three. The next step was to compute the heliocentric positions of Jupiter and Saturn for several months before and after November 15. These positions were then transformed to geocentric positions in ecliptic coördinates. The longitudes of the two planets were then plotted against

the times and the graphs showed there were three conjunctions and indicated the approximate time of each.

Figure 1 shows the heliocentric positions of the Earth, Jupiter, and Saturn for thirty day periods from June 9, 1940, to March 6, 1941. The three geocentric conjunctions take place at "A," "B," and "C." The positions of the three planets when Jupiter and Saturn are at heliocentric conjunction are indicated by "H."

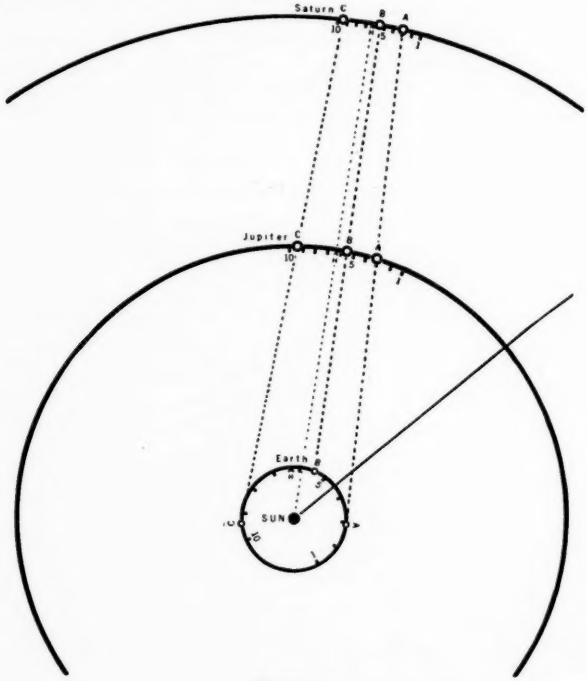

FIGURE 1

Figure 2 shows the geocentric positions of Jupiter and Saturn corresponding to the heliocentric positions given in Figure 1. It is seen that the two planets begin retrograding at almost exactly the same time.

Finally a second transformation was made changing the geocentric ecliptic coördinates into equatorial coördinates. Additional computations were made for the nearest days to the times of the three conjunctions in order to check the results secured by interpolation.

Taking the problem as a whole, the amount of computation involved is considerable. When exhibited in compact form covering several sheets of closely ruled paper, it never fails to impress a class in trigonometry with the work the astronomical computer must perform. By

comparison the computation required in the longest problems in trigonometry seems quite brief.

Historically speaking, this triple conjunction of Jupiter and Saturn takes place only at great intervals of time. According to Edersheim[3] this remarkable series of conjunctions did take place in May, October, and December of the year 747 A.U.C., or two years before the birth of Christ. Edersheim writes: "It was not only extraordinary but presented the most brilliant spectacle in the night sky, such as could not but attract the attention of all who watched the heavens, but especially those who busied themselves with astrology. In the year following, another planet, Mars, joined this conjunction." These dates are confirmed by Neugebauer[4] who computed the dates of the conjunctions to be May 22, October 8, and December 2, 6 B.C.

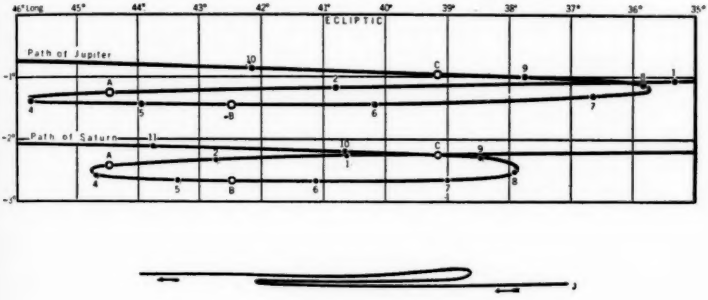

FIGURE 2

A TRIPLE CONJUNCTION OF JUPITER AND SATURN.
(Lower diagram indicates motion of Jupiter with respect to Saturn.)

Edersheim further writes: "The merit of first discovering these facts belongs to the great Kepler, who was led to the discovery by observing a similar conjunction in 1603-4. He also noticed that when the three planets came into conjunction a new, extraordinarily brilliant and peculiarly colored evanescent star was visible between Jupiter and Saturn, and he suggested that a similar star had appeared under the same circumstances in the conjunction preceding the Nativity."

Dr. Seiss[5] writes: "Kepler, on consulting the periods of the conjunction between Jupiter and Saturn, gave it as his opinion that such conjunctions astronomically coincided with the approach of each climacteric in human affairs: to-wit, the revelation of Adam, the birth of

[3] Edersheim: "Life and Times of Jesus."
[4] Neugebauer: "Astronomische Chronologie."
[5] Seiss: "The Gospel in the Stars," p. 435.

Enoch, the Deluge, the birth of Moses, the birth of Christ, the birth of Charlemagne, and the birth of Luther."

But this seems to be getting us into the realm of astrology so we would better stop at this point. But most of us, whether we believe in astrology or not, will agree that the present year brings another climacteric in human affairs and with it as in other climacterics let us hope the world may find another great leader who will guide the destiny of the human race away from the vortex of death and destruction into a new world of liberty and justice in which all nations may participate.

BAKER UNIVERSITY, BALDWIN, KANSAS, JULY 27, 1940.

Photographs of Venus in Red Light

By LATIMER J. WILSON

During April and May, 1940, a 12-inch aluminized reflecting telescope was employed to secure photographs of Venus in red, green, and blue light. The images formed at the principal focus were enlarged upon the negative film by projection in the telescope through an achromatic eyepiece in the form of a rectilinear lens. The negative images range between about 1.5 mm to 2.7 mm in diameter. Some of these originals possess areas of different density, and an effort was made to obtain prints which would show these probable markings.

The result is rather astonishing since certain patterns of dusky areas seem to be identified in images secured on different nights. Assuming that a particular spot is actually on Venus as indicated by the photographs, there appears to be a drift in longitude almost coinciding with that caused by the change in the angle of view produced by the relative motion of Earth and Venus. If this marking is real, apparently Venus keeps one side toward the sun as announced by Schiaparelli and Lowell; or, within error of measurement, possesses a very slow retrograde rotation. This matter concerning a possible rotation period, based upon such detail as disclosed in the photographs must be taken with the utmost reserve because of the uncertainty of the reality of the detail.

The fundamental principle recognized in the method of making the prints to disclose the markings is that described by Dr. William H. Wright (*Lick Observatory Bulletin,* No. 389, pp. 60-61). The particular application of that method employed here was as follows: the original images were enlarged 6 diameters on Eastman Regular Kodalith Film. Since 15 to 25 images were secured on the original negative, spaced about 2 mm apart (a time interval of about 5 or 6 seconds), some of the images exhibit better quality of "seeing" than others, and only the best were selected. Pairs of the best positive images were bound in register and printed in contact to produce a negative. The same contrast material was employed. The negatives thus secured were enlarged approxi-

mately 3×, the images again being registered in pairs. A contact print from these resulting enlarged positives produced the 18× enlarged negative. Prints from this, by contact, or enlargement were made on paper, and then reduced by copying on Process Film.

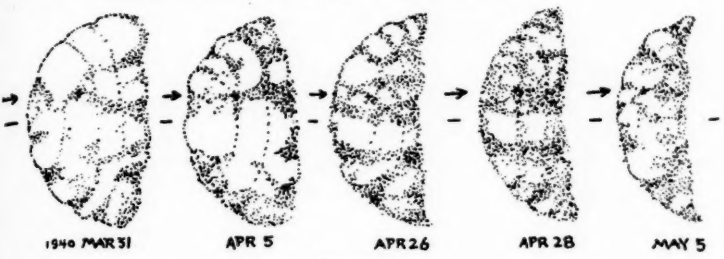

FIGURE 1
Traced from Contrast Prints; Dotted Lines mark Subsolar Concentric Curves; Arrows point to a Dark Area.

It might be interesting to mention here that an experiment was tried in making some negatives by contact-printing from the extreme contrast secured in paper positives. Unfortunately, difference in density in the paper itself introduced some spurious effects, but these can be identified readily when more than one negative from different prints are thus made. The resulting contrast is quite remarkable, and faint areas barely noticed are strongly presented. Slight diffusion can be secured by interposing a thin glass plate between the film and the paper, or, in projection, by slight out-of-focus adjustment. This helps to destroy the harsh graininess of the enlarged negatives. But here, again, spurious effects are introduced by minute dark or bright spots resulting from small holes, or from dust particles settling upon the films when drying. When such spots are diffused their real aspect is concealed and they appear as markings.

The apparent markings in a number of instances are repeated when various combinations of the original images are built up in the above described manner. The matter of precise register when two or more films are combined is difficult because the grain-patterns differ and their effect in giving shape to the particular detail is not seen. Registering the images merely by the limb and cusps may not produce perfect register, and the defect is not found until the image is built up strongly enough to become visible in the print. Therefore, the method applied to Venus has been exceedingly laborious.

As yet, a complete analysis of the more than 500 separate images has not been made. The film used for the red images was Agfa Superpan Press Film, and the filter was the standard Wratten No. 25, merely a bit of unmounted gelatin placed about 3 mm in front of the lens facing the film. Blue images were secured without a filter on Process Cut Film, or with the No. 47 filter, on Agfa Superpan Press Film. The green images

were secured on the same material through a No. 58 filter. Super Panatomic X film was also used for the red, and for no filter images.

The red images on April 5, 26, 28 show the greatest detail. The terminator in red images is also more extensive, and the diameter of the disk is larger (probably because of the high sensitivity of this film to red). The green images are smallest and show least terminator, while the blue images are intermediate in size. All exposures were about 1/10 second. Similar materials and exposures, applied to Mars in 1939, with same filters, gave largest disk diameters in the blue, and smallest in the red. Does this mean that Venus has an atmosphere which scatters long-wave radiation at higher levels than that of Mars?

The appearance of seemingly actual markings in the long-wave portion of the spectrum was not anticipated, since Dr. Frank E. Ross (*The Astrophysical Journal,* Volume LXVIII, No. 1, p. 64) and others have not photographed any markings in red light. The aspect of the apparent markings secured here, while suggesting a belt-like form, also suggests a circular series of disconnected shapes concentric with the subsolar area of the Venusian disk. From careful study of many prints made from different combinations of images, I believe both the belt-forms and these curved forms to be actual. A more detailed study will be presented later when time permits a full analysis of all of the negatives.

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Astronomy and Religion*

By LOUISE E. BALLHAUSSEN

[*The subject discussed in this paper was more frequently considered a quarter of a century ago than it is at present. In the course of the period referred to, the point of view here presented has come to be quite generally accepted by educated, thoughtful persons. This paper is therefore deemed worthy of publication to call attention to this indication of progress, if for no other reason.*—Editor.]

"This is my Father's world," says the churchman, the layman, and also the scientific astronomer; for the more he studies the construction of the universe, the more does he experience deep religious feeling while the stronger grows his faith in a Supreme Being. Inquiry into the structure of matter or of space by the experimental method is only one way of understanding Nature, whereas pious feeling is another vantage point. In order that our understandings may develop to the fullest possible extent, we need to profit from each of these points of view, as neither alone can give us a complete picture of life. Between these two different but complementary viewpoints of existence called science and

*Written in answer to questions asked by High School students.

religion, there should be and is no fundamental conflict.

My strong conviction in this matter has emerged gradually from intimate study of physics and astronomy at college; since then, it has continued to develop by exploring the attitude of profound thinkers, including Sir Arthur Eddington, Max Planck, Andrew Dixon White, and Robert A. Millikan.

It might be well at this point clearly to define the difference between theology, which often does contradict analytical knowledge, and true piety, which has no quarrel with it. We read in "Funk and Wagnall's Dictionary" "Theology is the branch of religious study that treats of God, His attributes, and of Creation," whereas "Religion is a belief binding the spiritual nature of man to a supernatural being, as involving a feeling of dependence with responsibility." In other words, theology constitutes a man-made interpretation of Scripture, while religion embraces man's attitude toward all the finest and deepest in life.

Not only in our own time does there exist a union between religion and astronomy, but throughout all mythology it appears that in the days of Greek and Roman culture, in ancient Egypt, even in primitive tribal nations, man's description of the heavens has been inextricably bound up with his faith. Wise men who eagerly observed the stars and planets in order to foretell events were priests as well as astronomers. They not only named the planets and conspicuous groups of stars after gods and goddesses, such as Jupiter and Venus, but also built temples to honor individual orbs, such as Arcturus. As early as 7000 B.C., according to Lockyer, some of the temples at Denderah in Egypt were oriented to the star Vega, which the Assyrians knew as the "Judge of Heaven." In India, the Hindus believed that the seven bright stars of Ursa Major (the Big Dipper) stood for the Seven Holy Persons who were supposed to live beyond Saturn; later, this constellation was connected with the Seven Champions of Christendom and the Lights of the Tower of Babel. Although most peoples have pictured the Dipper as a bear, yet in one legend it represents a peasant's wagon in which rode our Saviour near the shores of Galilee. Christians, moreover, have identified other aspects of the sky with divine symbols, such as the Northern Cross with the crucifix of our Lord; this sign hangs vertically above the western horizon every Christmas eve. Further illustrations† abound in mythology showing the close relation of the stars with faith.

Poets, too, often sing of both together, as in these verses by Habington: (from "Nox Nocti Indicat Scientiam" in Palgrave's "Golden Treasury")

> "When I survey the bright celestial sphere,
> So rich in jewels hung, that night
> Doth like an Ethiop bride appear:
> My soul her wings doth spread and heaven-ward flies,
> The Almighty's mysteries to read
> In the large volumes of the skies.

†For these, see "Star Lore of All Ages" by W. T. Olcott.

For the bright firmament shoots forth no flame
So silent, but is eloquent
In speaking the Creator's name."

Why then, since in so many cases astronomy and religion have gone hand in hand, do some people feel that study of the stars is inharmonious with religion, and *vice versa*? To my mind, the chief factors producing this misunderstanding are the exaggerated stress laid by the Christian Churches on the infallibility of the Bible and the latter's omission of indisputable technical discoveries. The Bible describes the religious history of the Jewish people. According to Dr. Robert A. Millikan, "Genesis is not to be taken as a modern text-book of science; it was written long before there was any such thing . . . It is of the utmost importance from every point of view to realize that the Bible itself makes no claims whatever of scientific correctness, or, for that matter, of verbal inspiration. It is, rather, the record of the religious experiences and development of a great race."[1] In this and other respects, it serves admirably. Many people, however, seem to expect it to enumerate all the detail that many years of painstaking research have revealed. Rather, let us appreciate Scripture in its proper spiritual sphere, but let physics show us purely mechanical details of the world. Of course God rules—but He reveals to us His methods through intellectual study.

Repeatedly history reveals a bitter struggle between secular knowledge and orthodoxy. For example, Dr. Millikan says, "Copernicus, an early astronomer, wrote his only book to show that all difficulties in explaining the movements of the heavenly bodies disappeared and all explanations came out far more simply if the earth was assumed to rotate once a day upon its axis and circle once a year about the sun. Realizing, however, that this new conception might arouse opposition because it robbed man of his central position in the scheme of things, he wrote to the Pope, to whom he dedicated his book; Copernicus asked him to use his influence to defend him from those who might attack the new theory 'Because of some passage of Scripture which they had falsely distorted for their own purposes.' Here is a devoutly religious man four hundred years ago of sufficient vision to see, even in the dim light of that shadowy age, that the foundations of true religion are not laid where scientific discoveries can disturb them."[2]

Again, from Dr. Millikan's booklet "Science and Life," "It is not a question of whether Galileo was right or wrong, of whether or not the earth actually revolves about the sun or the sun about the earth. That is a scientific matter with which religion has nothing whatever to do, which should not have given it the slightest concern . . . That even those persecutors of Galileo were far behind their own times . . . cannot perhaps be demonstrated better than by the following quotation

[1] R. A. Millikan, "Science and Life," p. 56.
[2] *Ibid.*, p. 6.

from St. Augustine, who lived about twelve hundred years earlier, about 400 A.D. He is probably recognized as the most influential authority, next to Jesus and St. Paul, of the early Christian Church. 'It very often happens,' says Augustine, in commenting upon the entire distinctness of the two great lines of thought, the natural and the spiritual, 'that there is some question as to the earth or the sky or the other elements of this world . . . respecting which one who is not a Christian has knowledge derived from most certain reasoning or observation: then it is very disgraceful, mischievous, and of all things to be carefully avoided, that a Christian speaking erroneously of such matters as being according to the Christian Scriptures, should be heard by an unbeliever who, perceiving him to be as wide from the mark as east from west, can hardly restrain himself from laughing.' "[3]

The point here is simply this: that there exists actually no real contradiction between religion properly understood and the findings of astronomers. Probably the simplest, most convincing proof of this statement is found in the testimony of great minds who have been leaders in both fields, such as Newton, whose life centered about 1680, Faraday, around 1830, Maxwell, 1870, Kelvin, 1890, and Lord Rayleigh, 1900, to mention only a very few. Lord Kelvin, a faithful churchgoer, first estimated the age of the earth; he said, "I believe that the more thoroughly geology is studied, the further does it take us from anything comparable to atheism." In addition, "If you think strongly enough, you will be forced by science to a belief in God, which is the foundation of all religion." Now let Pasteur speak in words inscribed over his own tomb: "Happy is he who carries a God within him, an ideal of beauty to which he is obedient—an ideal of art, an ideal of science, an ideal of the fatherland, an ideal of the virtues of the Gospel." Again, Henry F. Osborn, Director of the American Museum of Natural History as well as one of the foremost exponents of evolution, is an active church worker of deep religious conviction. In like manner, I could enumerate further as pious men a large proportion of eminent scientists of the past and present, of the Old World and the New.

Similarly, religious leaders willingly accept the contributions of research as harmonious and consistent with their own beliefs. "Was it not Jesus himself who said, 'Ye shall know the truth, and the truth shall make you free.'? Can you find one single syllable in all that He taught or one idea which He introduced into human life to justify anyone in arraying Him on the side of those who would see antagonism between any objective truth and the deepest of spiritual values?"[4] Scholars far greater than I have never succeeded in finding any.

"Now let me show why in the nature of things there can be no confiict between the two views. This appears at once as soon as one attempts to

[3] *Ibid.*, p .40.
[4] *Ibid.*, p. 48.

define for himself what is the place of each in human life. The purpose of reasoning from experiment is to develop without prejudice a knowledge of the facts, the laws, and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals, and the aspirations of mankind."[5] Moreover, since each contributes to a full, happy life in such a different way, neither alone is sufficient. Learning without spiritual guidance may become a curse, while theology by itself breeds dogmatism and bigotry. Particular creeds may come and go, but the essentials of Christianity consist of the life and eternal teachings of Jesus. What man is there who can disclose any astronomical discovery to controvert our Lord's spirit of unselfishness, His idealism, His belief in the brotherhood of man and the fatherhood of God?

Since the belief in God is fundamental in religion, let us analyze our conception of Him. Robert A. Millikan formulates it thus: "It seems to me obvious that every man who recognizes his own inability to comprehend the problem of existence or to understand whence he is going, must in the very admission of that ignorance and finiteness recognize the existence of a Something, a Power, a Being in whom and because of whom he himself 'lives and moves and has his being'."[6] That Power, that Something, that Existence, we call God. Not always, however, has man thus defined the Divine. Primitive man, naturally, thought of the Almighty as similar to himself—one who became angered and had to be appeased by human sacrifice. In the Bible we find that the Hebrews originally considered Jehovah to be concerned with their particular welfare only. Down through the ages, moreover, man's definition has broadened from that of a personal protector and jealous king to a loving father of all nations; finally, it has grown to include the spirit of love, nature, and the purpose behind the entire universe. I am reminded of the words of Tennyson from "The Higher Pantheism":

> "The sun, the moon, the stars, the seas, the hills, and the plains—
> Are not these, O Soul, the Vision of Him who reigns?
> Is not the Vision He?"

Although my conception probably differs from yours in detail, and each is somewhat vague, yet may we not both agree to use the word God to describe "that which lies behind the mystery of existence and that which gives meaning to it all."?[7] With this definition, is it possible for a thinking person not to believe in Him?

This truly is my Father's world—science shows not merely how He rules it in an orderly, progressive manner, but more than that it proves, if need be, says Millikan, that God Himself exists. "Science, in bringing to light the fact that this is not a world in which things happen by caprice but is a world governed throughout by law, has presented the

[5] *Ibid.*, pp. 50-51.
[6] *Ibid.*, p. 57.
[7] *Ibid.*, p. 59.

most powerful motive to man for goodness which has ever been urged upon him. That 'whatsoever a man soweth that shall he reap' remains no longer merely a Biblical text; it embodies a truth which has been forced into the consciousness of mankind by the last hundred years of the study of physics, chemistry, biology . . . It teaches mankind not only that disease breeds disease, but also, by inference at least, that dishonesty breeds dishonesty, that the wages of sin is death, and on the other hand that love begets love. It teaches him that the moral laws and the physical laws alike are all laws of Nature: that violations of either of them lead to disaster and to misery."[8]

"Men have repeatedly thrown away their lives for a cause. Why? Because men and women prefer to die rather than to live in the consciousness of having played the coward, of having failed to play their part worthily in the great scheme of things. . . . Most men believe that there is such a world scheme; that they play a part in it, that their deaths are going to contribute to its development; because, in short, most men believe in God."[9] Nora Waln, in her book, "Reaching for the Stars," quotes the Viennese's ever-current question "What is life? Why scourges, plagues, recurrent dark ages? What makes mankind survive every peril, and rise after every fall to reach again for the splendour of the stars?" Is the answer not the same belief in God?

Through study of physical laws and by means of detailed analysis of present movements and temperatures of the heavenly bodies, the astronomer extrapolates backwards in time to describe to us the beginning of things—he shows that at first, in the words of Sir Arthur Eddington in "The Expanding Universe," "The primordial state of things is an even distribution of protons and electrons, extremely diffuse and filling all spherical space, remaining nearly balanced for an exceedingly long period of time until its inherent instability prevails . . ." But, from where do the original electrons and protons come? At this point, the astronomer of necessity postulates a Creator, for no lesser Being or Force than the Almighty could bring matter into existence.

In appreciating the law and order of nature, I am reminded of an Arabian story called the "World of Chance."* The hero, Hafiz, was as happy a man as could be found in the whole earth until his two fine sons died from eating some poisonous mushrooms. Hafiz tore his hair in grief and bewailed his lot by crying, "Ah, why cannot I escape from this world of inexorable laws, the laws of nature, into a world where all that happens is governed by chance?" Worn out by his wailing, he rested beneath a tree in his garden and fell asleep. Very soon he saw in a dream a creature approaching him; it was not altogether an animal and yet not quite a human being. "You are so strange," began Hafiz, "Your head is so large that it is quite out of proportion. Your arms are absurdly

[8] *Ibid.*, p. 61.
[9] *Ibid.*, pp. 62-63.
*From "Other Arabian Nights" by Katibah.

long. And whoever heard of eyebrows being placed beneath the eyes?" "That is how I happened to be born," answered the ugly creature, "and everything in this World of Chance is just as strange. Notice the cattle —some sheep give birth to lambs and others to pigs—one never can tell ahead which it will be." As Hafiz marveled at these things, it suddenly became dark. "Is it an eclipse of the sun?" he inquired. "Not at all," replied his guide, "the sun has merely set. Here in the World of Chance we have no fixed days or seasons. The sun rises when it chances to rise, and sets when it chances to set. The darkness now may last a few minutes or perhaps a month." Meanwhile Hafiz explained how the sun behaved in a predictable way in his home country, the World of Law and Order. "How convenient and orderly must be your world. Here nothing necessarily stays as it is put or keeps its original shape." After observing other such strange things as rivers which changed their courses in a haphazard fashion, the trees which bore all manner of vegetables and fruits on the same limbs, besides others on their roots, you may be certain that Hafiz felt deeply grateful for a well-ordered universe, regulated by the unchangeable laws of nature.

As you know, the spectroscope enables one to find out what elements occur in any substance. By this instrument, the constitution of the stars, the sun, the earth, and even our own bodies has been found to be the same; every particle of matter in the whole vast universe is made of exactly the same building blocks as every other. For a while astronomers thought the sun contained an element existing nowhere on earth; hence they named the new substance "helium" from a Greek word meaning "sun." Now, however, as you know, helium has been discovered in the Texas oil fields, from which it is taken to fill dirigibles. Not only do the same elements exist everywhere, but also gravity behaves in the same manner in the remotest corners of space. That this is true is found by astronomers who study double stars.

In the wonderful universality of very simple laws of Nature such as the attraction of gravitation, again we discover the work of a Something no less than omniscient, a Ruler who works everywhere through law and order. Besides, we feel through all the beauty and goodness on this earth of ours a great Force working ever for the right. This grand conception of a universal Ruler and a positive Force for good is my idea of God.

"Increasingly, as the years roll by, the spirit of religion and the spirit of science are going to join hands, because the leaders of both fields are coming more and more to see life as a whole instead of each from his own narrow point of view. This is one of the places where you young people have your greatest opportunity to exert a very large influence upon your generation."[10] One event in this regard which is particularly encouraging is found in the following fact. A statement, endorsed by

[10] *Ibid.*, p .83.

many renowned men, upon the relations of science and religion was drawn up in 1923: It has been characterized by Bishop Johnson of Los Angeles as thoroughly pious; in addition, it calls for the recognition of the experimental method by all the signers, among whom we find such eminent religious leaders as Bishop Manning of New York and Dr. Henry Van Dyke of Princeton; outstanding students of nature including Charles Walcott, geologist, Michael Pupin, physicist, William Mayo, surgeon, and William Campbell, Director of Lick Observatory, besides such important men of affairs as Herbert Hoover and Elihu Root. Ninety-four per cent of all prominent scientists to whom that declaration of faith was submitted signed it unhesitatingly. After this showing, who can assert that non-Scriptural knowledge is materialistic and irreligious? I quote here the joint statement referred to above.

A Joint Statement Upon the Relations of Science and Religion (June, 1923)
By a group of Scientists, Religious Leaders, and Men of Affairs

We, the undersigned, deeply regret that in recent controversies there has been a tendency to present science and religion as irreconcilable and antagonistic domains of thought, for in fact they meet distinct human needs, and in the rounding out of human life they supplement rather than displace or oppose each other.

The purpose of science is to develop, without prejudice or misconception of any kind, a knowledge of the facts, laws, and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals, and the aspirations of mankind. Each of these two activities represents a deep and vital function of the soul of man, and both are necessary for the life, the progress, and the happiness of the human race.

It is a sublime conception of God which is furnished by science and one wholly consonant with the highest ideals of religion, when it represents Him as revealing Himself through countless ages in the development of the earth as an abode for man and in the age-long inbreathing of life into its constituent matter, culminating in man with his spiritual nature and all his God-like powers."[11]

In closing, let us consider man's place in this universe ruled by God, where His ways are made known through study as well as through faith.

Physically, the whole of mankind is formed of the same elements as inorganic matter, clinging to a small rock in space which whirls forever round a second-rate star. It seems unlikely that people live on any other planet besides the earth. You see this when you consider the conditions necessary for life. The star must emit fairly constant radiation, it must not vary rapidly nor greatly in brightness, although about half the

[11] *Ibid.*, p. 83.

known stars do thus change. The planet must revolve neither too close to the sun nor too far away; it must be covered by an atmosphere of certain gases, not liquid ammonia as around Jupiter. Also, it is likely that few planets do exist, for remember that our solar system was probably formed by huge tides caused by another star which passed very close to our sun. The possibility of such a near collision has been calculated to occur only two or three times in the whole history of this universe. In exploring our neighbor planets, we see that only Mars seems a fit abode for living creatures. Perhaps plants do already grow there—we observe color changes indicative of seasonal variations of vegetation, but there is hardly enough oxygen or water to support people. Our sun is only one of several trillion belonging to the Milky Way Galaxy in the immensity of space which contains thousands upon thousands of other such vast sytems of stars. "What is man, that Thou art mindful of him?"—a mere nothing in the vastness of space; a creature existing for only a million years out of the billions since Creation, breathing a mere fraction of a second in the eternity of time.

Yet wait, we must pause before relegating him entirely to the insignificant. What other being is there which can wonder about existence, which can ask "How?" and "Why?"? Is it not a wonderful feat that, without leaving this minute planet, he probes the interiors of stars so distant that he measures their remoteness not in miles but by the number of years it takes light to reach the earth? Light, you recall, is the swiftest of all messengers, traveling at the rate of 186,000 miles each second. Is it nothing that man can decipher numberless secrets of nature by means of a few bits of glass called spectroscope and telescope?

Far more important, however, than these intellectual achievements are man's questionings on the meaning of life and his realization that a great plan, a purpose, underlies the universe, and that he, ignorant mite though he be, belongs in this plan. Through his scientific studies he discovers how the world has progressed upward physically. Today, with this understanding, it behooves him to further the good work, to coöperate with the Almighty in continuing the spiritual ascent. The anthropologist shows how man has advanced beyond the apes; it is now his sublime duty, obligation, and reponsibility—it is a great challenge to each of us —to continue to rise spiritually, to press forward with science to make real on earth the Kingdom of God.

1 Gilmore Court, Scarsdale, New York, May, 1940.

Planet Notes for November, 1940

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac.*

Sun. Apparent positions of the sun for November 1 and December 1, respectively, are: $\alpha = 14^h\ 24^m.2$, $\delta = -14°\ 18'.9$; $\alpha = 16^h\ 27^m.7$, $\delta = -21°\ 45'.0$. The sun will be situated in the constellation Libra until November 23, when it enters the constellation Scorpio. On November 29 the sun enters the constellation Ophiuchus.

Moon. Phenomena of the moon will occur as follows:

		h	m
First Quarter	Nov. 6	21	8
Full Moon	15	2	23
Last Quarter	22	16	36
New Moon	29	8	42
Apogee	Nov. 11	16	
Perigee	27	12	

Mercury. Mercury will be an evening star during the first ten days of November, but too near the sun for easy observation. After November 11 it will be situated in the morning sky. Its greatest western elongation as a morning star will be on November 28, when it will be situated 20° west of the sun.

A transit of Mercury over the sun's disk will occur November 11-12. The ingress will be visible over most of North and South America (afternoon of November 11, local time), while the egress will be visible from Australia and Asia, principally. Details of the transit, with formulae for computing the times of contacts for any latitude and longitude, appear on page 27 of the January, 1940, issue of POPULAR ASTRONOMY, or may be found in the *American Ephemeris and Nautical Almanac* for 1940.

Captain J. F. Hellweg, Supt., U. S. Naval Observatory, Washington, D. C., has called attention to the importance of the transit as a means to secure data for checking the orbit of Mercury and the rotation of the earth, and he urges amateur and professional astronomers alike to exert every effort to observe accurately the times of the contacts. Only the ingress, or in other words, the first and second of the four "contacts" can be observed in North and South America. Full mimeographed instructions on how to observe the transit, and on what to expect, will be sent to any amateur or professional astronomer by the U. S. Naval Observatory on request. These instructions are in the main reproduced in this issue of POPULAR ASTRONOMY through the medium of the article, "Transit of Mercury, November 11, 1940," by J. F. Hellweg. Here is an occasion where the amateur astronomer can make a valuable observation, if he will take the trouble to provide himself with the correct time and to work out the details of his observational procedure carefully in advance, proceeding scientifically according to the instructions furnished free of charge by the U. S. Naval Observatory.

Venus. Venus will still be a brilliant morning star during November. Its stellar magnitude during the month will be about —3.5. Information of interest to observers is tabulated on page 28 of the January, 1940, issue of POPULAR ASTRONOMY. On November 26 an occultation of Venus will occur. The occultation will not be visible from the United States as such, but will appear as a close ap-

proach of Venus to the northern limb of the moon. The time of conjunction in right ascension is November 26, $21^h\ 32^m$.

Mars. During November, Mars will be moving rapidly eastward through the constellation Virgo. During the first part of the month the planet will be located not far to the north of the bright star Spica.

Jupiter. Jupiter will be in opposition with the sun on November 3, and the stellar magnitude of the planet will be —2.4 at that time. The planet is moving slowly westward in retrograde motion through the constellation Aries, not far from Saturn. An occultation of Jupiter will occur on November 13, invisible from the United States.

Saturn. Saturn will be in opposition with the sun on November 3, and its stellar magnitude will be about 0.0 during November. An occultation will take place November 14, invisible from the United States.

Uranus. Apparent positions of Uranus for November 1 and November 30, respectively, are: $\alpha = 3^h\ 29^m.9$, $\delta = +18°\ 41'.9$; $\alpha = 3^h\ 25^m.1$, $\delta = +18°\ 24'.6$. Opposition with the sun will occur on November 16.

Neptune. Neptune is now in the morning sky but too close to the sun for observation.

Occultation Predictions

(Taken from the *American Ephemeris*)

Date 1940	Star	Mag.	Immersion: Greenwich C.T.	Immersion: a	Immersion: b	Immersion: Angle E from N	Emersion: Greenwich C.T.	Emersion: a	Emersion: b	Emersion: Angle E from N
	Occultations Visible in Longitude +72° 30′, Latitude +42° 30′		h m	m	m	°	h m	m	m	°
Nov. 3	95 B.Sgr	5.8	23 59.7	—0.8	—0.8	77	1 4.7	—0.5	—1.2	263
4	ρ Sgr	4.0	20 51.9	—2.2	—0.3	108	22 5.3	—1.6	+0.6	230
10	98 B.Psc	6.4	23 42.7	—2.5	+0.2	111	0 39.7	—0.7	+3.2	195
12	73 Psc	6.2	0 49.9	—1.9	+1.2	81	2 13.2	—1.6	+1.7	226
16	63 Tau	5.7	3 58.1	—2.0	+0.5	96	5 21.5	—1.9	+1.4	240
17	115 Tau	5.3	11 14.5	—0.7	—0.5	63	12 7.6	+0.2	—2.2	306
18	BD+18°1112	6.4	5 22.3	—1.5	+3.3	44	6 22.1	—2.1	—2.1	314
18	124 H.^{1}Ori	5.7	7 27.0	—2.0	—0.4	96	8 53.0	—1.8	—0.9	273
18	292 B.Ori	6.5	11 41.7	—0.7	—1.0	79	12 41.1	0.0	—2.0	299
20	30 B.Cnc	6.1	12 40.4	—1.2	—0.7	72	13 34.2	—0.1	—2.5	322
22	89 B.Leo	6.3	12 29.2	..	..	52	13 4.6	..	..	356
23	35 Sex	6.3	7 5.9	—0.6	—0.3	136	8 6.4	—1.1	+1.4	263
	Occultations Visible in Longitude +91° 0′, Latitude +40° 0′									
Nov. 3	95 B.Sgr	5.8	23 40.1	—1.4	—0.2	66	0 52.5	—1.3	—1.3	276
10	98 B.Psc	6.4	23 9.7	—1.2	+1.3	96	0 15.5	—0.9	+2.5	215
12	73 Psc	6.2	0 19.5	—1.1	+2.0	66	1 39.0	—1.5	+1.7	244
16	63 Tau	5.7	3 26.5	—1.2	+1.5	84	4 44.7	—1.5	+1.6	247
17	115 Tau	5.3	10 58.4	—1.2	—1.0	87	12 9.2	—0.6	—1.7	282
18	BD+18°1112	6.4	4 56.1	—0.5	+3.6	37	5 46.6	—2.0	—1.2	315
18	124 H.^{1}Ori	5.7	6 49.0	—2.0	+0.2	103	8 15.5	—2.2	+0.6	258
18	292 B.Ori	6.5	11 26.6	—1.2	—1.5	103	12 38.9	—0.8	—1.5	275
19	λ Gem	3.6	13 0.4	—0.8	—1.5	105	14 7.4	—0.4	—1.6	283
20	30 B.Cnc	6.1	12 16.7	—1.5	—1.2	101	13 31.2	—0.9	—2.0	296
22	89 B.Leo	6.3	11 43.0	—2.2	0.0	92	12 58.2	—1.3	—2.1	318
22	π Leo	4.9	13 9.7	—1.8	—0.8	98	14 23.3	—1.1	—2.2	312
23	35 Sex	6.3	6 59.4	—0.2	—0.7	146	7 45.8	—0.5	+2.1	248

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′

Nov. 11	73	Psc	6.2	23	57.5	0.0	+2.0	55	0	59.9	—0.6	+1.4	263
12	88	Psc	6.2	7	56.4	..	..	0	8	29.3	..	..	314
16	63	Tau	5.7	3	4.9	0.0	+1.8	64	4	6.5	—0.6	+1.2	268
17	115	Tau	5.3	10	11.5	—2.3	—1.5	115	11	34.1	—2.2	+0.4	245
18	124	H.^{1}Ori	5.7	6	4.3	—0.8	+1.1	93	7	16.7	—1.2	+1.4	257
18	292	B.Ori	6.5	10	46.2	—2.0	—3.0	140	11	52.4	—2.6	+1.7	232
19	λ	Gem	3.6	12	36.7	—1.2	—3.7	151	13	33.7	—2.6	+1.0	236
20	30	B.Cnc	6.1	11	31.6	—1.8	—2.4	143	12	43.2	—2.7	+0.9	249
21	209	B.Cnc	6.5	14	31.6	—2.0	—0.6	90	15	44.5	—1.0	—2.4	315
22	89	B.Leo	6.3	10	53.2	—1.3	—0.6	129	12	7.9	—2.0	+0.6	271
22	π	Leo	4.9	12	23.2	—1.5	—1.8	145	13	35.2	—2.5	+0.5	262
24	9	B.Vir	6.2	12	19.8	—1.5	+1.6	80	13	18.6	—1.0	—1.6	331

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Comet Notes

By G. VAN BIESBROECK

A first observation of the expected PERIODIC COMET 1933 *f* (WHIPPLE) has been announced by the Harvard Observatory. The object was found on a pair of photographs made by L. E. Cunningham with the 12-inch Metcalf refractor at Oak Ridge, Massachusetts:

1940 Sept. 1.1486 $22^h\ 34^m\ 8^s.1$ —0° 15′.9 Magn. 15. Diameter 10″.

This comet was first discovered at the same observatory, October 21, 1933, by F. L. Whipple. It remained faint but favorably situated until March, 1934. After a gap of several months further observations were made in the fall of 1934 and continued at the Lick Observatory until January 31, 1935. From these observations a good orbit was computed by Cillié and Johnson (*Harv. Circ.* 409, 1935) indicating a period of 7.5 years. This orbit was recently brought up to date with the inclusion of planetary perturbations since the first apparition and led to an ephemeris which proved to be quite accurate: the above position differs by only 6′ from the prediction. A correction of 0.23 day earlier in the predicted date of perihelion passage, January 22.264, 1941, gives a satisfactory representation. The corrected ephemeris is thus as follows (*Harv. Ann. Card* 531):

1940 0^h U.T.	α (1950.0) h m s	δ ° ′	—Distance from— earth	sun	Magn.
Oct. 2.0	22 19 49	—4 17.3	1.696	2.587	14.2
10.0	18 47	5 10.0	1.745	2.573	14.3
18.0	19 18	5 53.2	1.806	2.561	14.5
26.0	21 23	6 25.7	1.877	2.549	14.6
Nov. 3.0	25 1	6 47.0	1.955	2.538	14.7
11.0	30 6	6 57.0	2.040	2.528	14.9
19.0	36 32	6 55.9	2.129	2.519	15.0
27.0	22 44 9	—6 44.6	2.221	2.511	15.0

On September 3, 4, and 5 the comet was examined with the 40-inch refractor and I recorded it as a centrally condensed round coma, about 12″ in diameter and of visual magnitude 14.5. This is a little fainter than the ephemeris value. Although well situated in the constellation of Aquarius, it will, therefore, be observable only in larger telescopes.

In a letter dated July 14, the Tokyo observer H. Hirose mentions that he has located COMET SCHWASSMAN-WACHMANN I (1925 II) photographically as follows: 1940 July 4.6635 $20^h\,4^m\,47^s$ $-25°\,44'.4$ Magn. 13 (1950.0).

Fairly large round nebulosity with little central condensation. S. Kanda had supplied him with a search ephemeris. L. E. Cunningham has continued the ephemeris as follows, after correcting it according to the above observation:

0^h U.T.	α h m s	δ ° ′
1940 Oct. 2	19 38 6	−25 3
10	39 48	24 48
18	42 16	24 32
26	45 26	24 14
Nov. 3	49 15	23 55
11	19 53 40	−23 35

A confirmation of the Japanese observation has not been secured so far. It would be of interest to obtain it before the comet is lost in the evening sky. It will be remembered that this is the comet which has shown in the past very striking changes in brightness and appearance.

Williams Bay, Wisconsin, September 12, 1940.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

This August, as the moon was favorable, it was hoped that very intensive work would be done on the Perseid meteors. With this in view I made an attempt to reach the public through the press. As a result, the papers in this region gave wide publicity to these meteors but the paucity of results from states at a distance would imply that, for some unknown reason, the papers in such states failed to carry the notice. In this region, however, thanks to their aid, good results were obtained despite cloudy weather for most stations on the night of presumed maximum as well as on the following one.

In this communication I will restrict myself to what was done within a radius of about a hundred miles or less. This includes the work of persons observing alone and not members of the A.M.S., who had not been furnished with specific instructions and also the work of several groups, organized directly or indirectly from Flower Observatory, who were working for given hours in specific directions. This work was obviously planned with the hope that large numbers of meteor heights would be derived from the observations made on the same meteors from two or more stations. Naturally it has as yet been impossible to make the actual computations and so the heights obtainable from this campaign cannot appear until some future time.

The plan was to observe on the nights of August 10/11, 11/12, and 12/13; on

the first two from midnight to dawn, on the third from 13 hours to dawn, clouds, etc., permitting. Taking our network as a whole, the first night was favorable, the second almost wholly cloudy, and the third mostly cloudy. So most of the really valuable results will be restricted to the first night. Besides the visual observations, photographs were taken with some of the powerful cameras at Cook and Flower Observatories. In addition to the staffs of both these observatories and members of the A.M.S., we had the able assistance of three groups of the Amateur Astronomers of the Franklin Institute. Though these were the first meteor observations made by many of them, yet their results show up well and form the bulk of this report. Their help was hence invaluable, and I hope that this is but the beginning of coöperation in research which will be to the mutual advantage of all concerned. Indeed it has always been my desire that Flower Observatory should be a center not only of professional activity by its staff but of as many amateurs and others who cared to take part. Two lists follow; one of our network observers, the other of persons who kindly assisted without special instructions. Each gives station, observer, factor, time of beginning and ending, number of meteors observed, and notes. At Cook and Flower Observatories, on August 10/11, the observers concentrated upon the regions to which the cameras pointed and hence did not observe all the meteors seen. Their results can not therefore be used for rates. In any case, the rates at both places would not be comparable to those from stations far from the city. Several men attempted to observe from other places but clouds prevented; their names are omitted. The tables show that our 23 network observers recorded 650 meteors; perhaps 70% be-

TABLE I

Station	Observer	Factor	Date Aug.	Hours E.S.T.	Met.
Flower Obs., Pa.,	S. G. Barton	0.2 to 0.8	10/11	9:35 14:45	37
	P. H. Taylor				
	Mrs. P. H. Taylor				
	C. P. Olivier	0.1 to 0.0	11/12	11:50 12:30	3
	Mrs. C. P. Olivier				4
	C. P. Olivier	0.3	12/13	13:25 14:30	12
	Mrs. C. P. Olivier				11
Cook Obs., Pa.,	R. K. Marshall	0.2 to 0.7	10/11	9:44 14:49	53
	J. S. Thompson				
	Bailey				
Roxborough, Pa.,	R. Shutts	0.3 to 0.7	10/11	9:57 11:57	34
	A. Eichelberger				
	A. Liss				
	M. Cassidy				
	A. Paul				
Fox Chase, Pa.,	E. Klein	0.8	10/11	10:12 13:58	161
	A. Busdu, R. Gorson				
	J. Lauchak				
Ardsley, Pa.,	H. Smith	0.7	10/11	10:45 14:25	38
	R. Funch				
	B. McManus				
Ardsley, Pa.,	H. Smith	0.8 to 0.0	11/12	7:49 12:34	89
	R. Funch, B. McManus				
	R. Wardner				
Doylestown, Pa.,	C. P. Olivier	0.5	10/11	11:30 15:07	54
	T. D. Cope	0.7			43
West Creek, N. J.,	G. Rosengarten	1.0	10/11	12:00 16:00	105
Philadelphia, Pa.,	R. Gorson	0.1	11/12	11:46 12:55	6
Total					650

ing plotted. The 9 other observers saw 604 meteors, about 8% being plotted. It is hoped that some of these 8% will prove to be duplicates of meteors observed by the network groups.

Making allowance for the very poor conditions on August 11/12, the night of probable maximum, the Perseids seem to have returned in their usual numbers. Comparatively few brilliant meteors were seen and 10 seconds was the longest duration of any train reported. When results from a distance have all presumably arrived, a résumé of them will be given. Meantime I wish to express most hearty appreciation for the excellent coöperation and good results of our many helpers in the local campaign whose names have been mentioned in the tables.

TABLE II

Station	Observer	Factor	Date Aug.	Hours E.S.T.	Met.	(*)
Collingdale, Pa.,	J. D. Truxton	0.8	10/11	11:30 13:30	166	*1
	with assistant	0.2	11/12	12:30 14:10	43	*2
		0.4	12/13	14:00 15:55	49	*2
Bryn Athyn, Pa.,	Mrs. R. M. Cole.	0.2 to 0.8	10/11	9:50 12:20	42	*3
Westminster, Md.,	Miss L. M. Young	1.0	10/11	13:15 14:15	21	*4
		0.5	11/12	13:45 15:30	36	*4
Flemington, N. J.,	J. Caka III....	1.0	10/11	11:45 15:00	98	*5
		0.7	11/12	11:45 13:30	37	*5
		0.7	12/13	11:45 13:45	16	*5
Blue Bell, Md.,	C. Brown.....	1.0	10/11	13:00 14:00	52	*6
Baltimore, Md.,	Dr. H. F. Hanson		11/12	10:00 10:45	3	*7
Milton, Pa.,	Miss L. M. Smith...	0.5	10/11	12:15 14:35	14	*8
		0.8 to 0.5	11/12	12:39 14:42	27	*8
Ambler, Pa.,	J. R. Knight	0.8	10/11	13:06 14:05	0	*9
Total					604	

NOTES: *1—133 Perseids; *2—37 Perseids; *3—36 Perseids; *4—Counts, fireball plotted; *5—Quarter-hour counts; *6—Count; *7—Described; *8—Plotted; *9—Two photos.

1940 August 20, Flower Observatory, Upper Darby, Pennsylvania.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
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Note on the Surroundings of the Goose Lake, California, Siderite in Situ

By FREDERICK C. LEONARD

Attention is called to an article—largely supplemental to my several papers[1]—on "The Giant Goose Lake Meteorite from Modoc County, California,"[2] by Professor Earle G. Linsley of the Chabot Observatory, Oakland, California, a member of the party of five fellows of the S.R.M. (himself, A. D. and H. H. Nininger, R. W. Webb, and myself) who recovered the siderite in May, 1939, and arranged for its exhibition at the Golden Gate International Exposition on Treasure Island in

San Francisco Bay, where it is on display again this season (1940). I quote from the second from the last paragraph of this article: "There was no evidence of shattered rocks indicating a recent fall and there were no skid marks to show that the meteorite had swept along the surface and come to rest where it was found. There was only the slight depression in which it rested, *which appeared to be due in part to wind erosion as the air currents had eddied about it*" (Italics mine). The depression referred to was the "almost circular, saucer-like depression or 'crater,' about five feet in diameter and one foot deep,"[3] concerning which I remarked (*loc. cit.*[3]): "This formation was the only visible evidence, if evidence it was, of the impact of the body with the ground." I quite agree with Professor Linsley in his explanation of this crateriform depression, which I believe now was due *solely* "to wind erosion as the air currents had eddied about" the siderite. In my opinion, there was *no* external evidence of the fall of the meteorite *in situ*: any such evidence as might at some time have existed was probably entirely effaced, long before the specimen was discovered.

REFERENCES

[1] See, *e.g.*, *C.S.R.M.*, **2**, No. 2, 113-15, 145-6, 1939; *P. A.*, **47**, 322-4, 507-8, 1939; *The Griffith Observer* (Los Angeles), **4**, 1-8, 1940.

[2] *Calif. Jour. Mines & Geol.* (San Francisco), **35**, 308-12, 3 figs. & bibl., 1939.

[3] *C.S.R.M.*, **2**, No. 2, 115, 1939; *P. A.*, **47**, 323, 1939.

New Data concerning the Fall of the Great [Tungus] Meteorite on June 30, 1908, in Central Siberia*

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with Critical Commentaries by LINCOLN LA PAZ†

ABSTRACT

This article contains a brief review of previous research; chiefly, however, new data concerning the fall of the Tungus, central Siberia, meteorite on June 30, 1908. New testimony of eyewitnesses was collected by the author and others in 1928-32. A map of the region of the fall has been plotted. The meteorological conditions on the morning of June 30, 1908, have been studied on the basis of data from meteorological stations in central Siberia. The atmospheric phenomena accompanying the flight were studied with the aid of barograms from Siberian and European stations as well as seismograms recorded at Irkutsk. On the basis of sound phenomena and data supplied by barograms and seismograms, the moment

*Published originally in the *Astr. Jour. of the Soviet Union*, **10**, 465-86, 1933. A brief English abstract and extensive bibliography were published by Astapowitsch in *P. A.*, **46**, 310-17, 1938. Unfortunately, errors appearing in the original remain uncorrected in this abstract and the carefully collated map published in Astapowitsch's original paper has here been omitted.

†Translated from the Russian of I. S. Astapowitsch by Gerhard Wiens, at the suggestion and with the coöperation of Lincoln LaPaz. Words, symbols, and critical commentaries inclosed in square brackets [ ] have been inserted by the senior translator, who wishes to express his appreciation of a grant generously provided by the Graduate Council of the Ohio State University to cover expenses incidental to the preparation of this translation.

of the explosion of the meteorite was determined (as $0^h\,16^m$ G.M.T.). On the basis of investigations of acoustic and light phenomena, an estimate of the number of wind-fallen trees, the amplitude of oscillation of the atmospheric pressure at Slutsk and in England, and, finally, a comparison with other phenomena, the order of the work done by the explosion was calculated and found to be [between] 10^{23} and 10^{24} ergs. From the testimony of eyewitnesses, the brightness, color, and form of the head and the envelope of the meteorite, the character of the explosion, and the geocentric velocity were determined. Bounds for the [positions of the] trajectory and the radiant of the meteorite were found. [In §10 of this translation a simplification and an extension of Astapowitsch's discussion of the position of the trajectory and the radiant are given.]

Introduction.—Among the known great meteoritic phenomena of the last several thousand years, the fall of the meteorite of $0^h\,16^m$ G.M.T., June 30, 1908, must be placed in probably the front rank as far as the grandeur of the phenomena accompanying its movement within the limits of the Earth's atmosphere is concerned.[31]‡ At the present time [1933], exactly a quarter of a century after the fall of the meteorite, it is occasionally rather difficult to ascertain some of the aspects of the phenomenon, and certain details we must consider lost irrevocably. The sparse population (about one person per square km., and even less in the region of the most pronounced effects of the fall of the meteorite), the considerable distance from the civilized inhabited zone (700 km. from the railroad, 450 km. from Kirensk, 910 km. from Irkutsk, along a straight line, *etc.*), the superstitious fear of the natives, which to this day has preserved the legend about the God of Thunder, Ogda, who descended to their abode from heaven (as in the analogous legends among the Navajo Indians of northern Arizona[I]§ [concerning] Canyon Diablo [or] Meteorite Crater), the general ignorance of the people (encouraged by the czarist government), and, finally, the enormous [extent of the] territories, covered almost totally by taiga forest and swampy marshes and [crossed by] rivers full of rapids—these are the reasons why not enough attention was given to this phenomenon at the proper time and why its investigation was begun as late as 1921, after the October revolution.[21]

§1. *Summary of Previous Research on the Meteorite.*—A. V. Voznessensky was the first to gather and to study important documents based on observations of the meteorite on June 30, 1908. While investigating the earthquake of June 28, 1908, at $18^h\,44^m$ G.M.T., registered at Irkutsk, Chita, and Kabansk (subsequently No. 1535, according to the "List of Earthquakes in 1908"), he sent questionnaires to various correspondents; this earthquake was noticed east of Irkutsk by many people, as well as the one following it, No. 1536, which began at $0^h\,19^m.2$ G.M.T., June 30, 1908 ($7^h\,16^m.4$ Irkutsk time), with its maximum phase at $^h\,20^m.1$, noted mainly in the southern part of central Siberia. In connection with this, many of the observers noted sound phenomena resembling the discharges of heavy artillery, or loud thunder, with the weather calm and fair, at 8:00 A.M. The correspondents from regions farther north reported also light phenomena in full sunlight and drew attention to the fall of a bright detonating meteor.[15] In the course of the next few weeks, the newspapers *Golos Tomska*,[2, 3] *Sibir*,[5, 6, 4] *Sibirskaya Zhizn*,[7]

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‡Arabic numbers refer to titles in the bibliography at the end of the abstract in English published by I. S. Astapowitsch in *P. A.*, **46**, 310-17, 1938, *q.v.*

§Roman numbers refer to titles in the bibliography at the end of this translation, *post.* [The reader is referred to the concluding instalment.—ED.]

and *Krasnoyarets*[8] carried various observations and descriptions of this phenomenon. By chance, one such description, written by Adrianov,[7] was reprinted in O. Kirchner's calendar (with detachable leaves) for 1910, on the reverse side of the leaf for June 2/15.[1, 11] D. Sviatsky found this leaf while working on the history of astronomy, and in March, 1921, gave it to L. Kulik for the Mineralogical Museum of the Academy of Sciences, [23] where, on the initiative of V. Vernadsky, a meteorite expedition was organized for the collection of meteorites that had fallen in the years of the World War and the [Russian] civil war [1917-20].[10]

The collection of information concerning the fall of the [Tungus] meteorite was included in the plan of the expedition headed by L. Kulik, and, in 1921-22, considerable material was gathered in Siberia from several dozen eyewitnesses of the phenomenon;[10] (see also references (11, 12, 13, 14) and particularly the interesting résumé of L. Kulik[19] [see likewise the translation in the *C.S.R.M.*, **1**, No. 1, 29-34; *P.A.*, **43**, 499-504, 1935]). It became evident that the meteorite flew "in the general direction from south to north" (L. Kulik[10]), as has been confirmed by some of the latest research (see hereafter), and fell probably in the basin of the river Vanovara, a right-hand tributary of the Central Podkamennaya Tunguska (Khatanga), between 5:00 and 8:00 A.M., June 17/30, 1908. It was learned that a considerable part of the taiga forests was damaged by the action of the air-wave,[10] that the trembling of the Earth was felt to a distance of several hundred km. from the place of the explosion, and that the rapid flight of the meteorite was observed directly by many people, as well as the powerful explosion (testimonial in L. Kulik,[10] A. Voznessensky,[15] correspondence,[2, 3, 5, 6, 7, 8] particularly L. Kulik[19-20] [see the translation in the *C.S.R.M.*, **1**, No. 1, 35-9; *P. A.*, **43**, 596-9, 1935]). The sound phenomena were observed everywhere; the farthest point to the north was the Turukhansk region, [on] the river Enissey [Yenisei], at the village Vereschagina (A. Y. Tugarnikov [Tugarinov?][19]); *i.e.*, at a distance of about 1000 km. from the place of the explosion; [the farthest point] to the south was the Minussinsk taiga (see hereafter). Unfortunately, the data in the questionnaires contain little information concerning the exact direction of the flight.

S. Obruchev, who conducted geological research on the river Khatanga in 1924, points out,[16] as do L. Kulik and A. Voznessensky, that the meteorite passed approximately over the former Kansk district in a northerly direction and fell near the river Vanovara. Obruchev obtained the first interrogatory map of the region of the wind-fallen trees, prepared by the Tunguses, and indicated as its center the coördinates $\phi = +60° 20'$ and $\lambda = \text{E. } 102° 0'$. The Tunguses denied, possibly for religious reasons, that the meteorite had fallen,[16] agreeing to show only the [region of the] wind-fallen trees, whose area, according to them, attained 680 square km.

I. Suslov[17] prepared another map during the *suglan* (convention) of 60 nomad Tunguses at the Chunsk railway station. It was found that the center of the region of wind-fallen trees, the location of the holes formed supposedly by the fall of the meteorite, the epicenter of the earthquake, and the center of the explosion, lie near one another. I. Suslov conducted his investigations independently of the work of A. Voznessensky. These materials were collected by L. Kulik in the Meteorite Department (established by the previously-mentioned meteorite expedition) of the Mineralogical Museum of the Academy of Sciences and were published by D. Sviatsky.

All this activity stimulated the organization of an expedition to discover the meteorite; this expedition, under the leadership of L. Kulik, was sent out by the

Academy of Sciences in March, 1927.[23] It determined the location of the area [of fall], 20-30 square km., in relation to which the wind-fallen trees turned out to be located radially, with the tops of the trees lying away from the center. This area lies on the watershed between the rivers Khushmo and Kimchu [Kimtchu] and is very swampy, on account of the lack of drainage off of the plateau. Trees protected by hills remained standing, but they, too, were without their tops, which had been torn off by the air-wave; these tree-tops, however, were not discovered anywhere in the vicinity, either by this expedition or by the two subsequent ones. It was discovered that the central part of the area of wind-fallen trees had been subjected to the action of a very high temperature lasting but a short time, and that a thin, scorched layer uniformly covered the trunks of the prostrated and the isolated upright trees over a distance of many km. The study of the data compels one to reject any assumption of forest fires, so frequent in the taiga in the summer, but causing damage of an entirely different character.

The next expedition (1928) made a magnetometric survey by means of a deflecting magnetometer, with the purpose of disclosing the iron mass of the meteorite, since, according to the Tunguses, they had found small pieces of metal "brighter than the blade of a knife and resembling in color a silver coin." The expedition determined three astronomical points (S. Bielykh[29]); made a survey of the region lying within the previously-mentioned plateau, which is surrounded by a chain of mountains and is located some 90 km. (along an air line about 60 km.), northwest of the Gostorg trading-station Vanovara, along the new winding path, 6 km. north of the mouth of the stream Churgima, the left tributary of the river Khushmo, which flows into the river Chambe. Here the turf covering is thrown out in some places and whole layers of turf are seen turned upside down[24, 36, 25, 63, 33] or are gathered into folds as a result of the pressure of the wave caused by the explosion, each fold measuring several meters. This effect can be seen also in the moving pictures of the expedition taken by N. Strukov (Sovkino), which served later as the basis of an educational film.[25] The region was explored and a general description of it was made.

The work was continued by the third expedition of the Academy of Sciences, which departed from Leningrad in February, 1929, and returned at the end of 1930; its report, which [has been] published in the *Works of the Institute of Mineralogy,* gives brief data on the results of the work.[63] [Astapowitsch next quotes at some length from the Kulik report. A translation of the complete report appears in the *C.S.R.M.*, **1**, No. 2, 15-20; *P. A.*, **44**, 215-20, 1936.]

Today all the material concerning the fall of the meteorite of June 30, 1908, which we shall, for the sake of brevity, call the *Tungus meteorite,* the name now commonly used, is collected in the Meteorite Department of the Mineralogical Museum of the Academy of Sciences; there it is being studied by L. Kulik who is chiefly responsible for its investigation and to whose energy we owe much in connection with the gathering of data for the study of this meteorite. A great many reprints of the basic literature mentioned previously have appeared in the Soviet and in the international press (see references 28, 27, 32, 33, 35); see also the notes by Stenzel,[43] N. Bobrovnikoff,[41] and Merrill,[45] as well as the literature consisting of translations from original sources (see references 34, 46, 47, 48, 56).

It is interesting to compare the fall of the Tungus meteorite with that of the small (1912-g.) stone meteorite, Kagarlyk, which fell in the middle of June, Old Style, of the same year, 1908, [1908, June 30, 7 A.M., according to Prior's *App. Cat.* Museum of the Academy of Sciences; there it is being studied by L. Kulik who is

the collection of the Mineralogical Museum. The author found that several meteorites which fell between June 20 and July 5 in the last thirty years were stone meteorites, for the most part medium chondrites; this problem should be studied separately; first of all, the fall of the meteorites on July 4, 1917, at Colby, Wisconsin, U.S.A., and on June 30, 1918, at Richardton, North Dakota; [for relevant] literature, [see], *e.g., Zentralblatt für Mineralogie, etc.*

V. Vernadsky thinks[59] that it is not impossible that the [Tungus] meteorite was a compact cloud of cosmic dust passing through the atmosphere and causing the extraordinary development of silvery clouds between June 30, and July 2, 1908. We know of no other analogous phenomena in [the history of] meteoric astronomy, unless we count the *"Staubmeteoren"* of Hoffmeister;[II] besides, the mechanism of the appearance of a dust cloud moving with cosmic velocity through the Earth's atmosphere is not known.

§2. *New Data from Eyewitnesses.*—The author began his study of the Tungus meteorite at the end of 1928.[40] In the course of the astronomical and geophysical expeditions of 1930, 1931, and 1932, on the rivers Angara and Lena, he gathered new data supplemented at Irkutsk and Leningrad. These data follow: the author's notes are inclosed in *parentheses.*

1. At Bratsk (a village at the confluence of the rivers Oka and Angara), the observer of the meteorological station, B. Y. Kovalsky, entered in the record for June 30, 1908, when the sky was absolutely clear and there was no wind: "About 7 A.M., frequent dull explosions were heard below the river Angara (*i.e.,* almost exactly over the village); in several huts the dishes and the glass in the windows were observed to shake. Here [is] an unprecedented phenomenon."

2. At Enisseysk, K. F. Lytkin recorded in the meteorological journal at the first observation at 7 A.M., a distant [clap of] thunder.

3. At Kezhma on the Angara (there is still another, Upper Kezhma, also on the Angara, at Bratsk), A. K. Korin adds to the remarks on the meteorological observations for June 30, 1908 (archives of the former Irkutsk magnetic and meteorological observatory): "At 7 A.M., there appeared in the north two fiery circles of colossal dimensions; 4^m after their appearance, the circles vanished; soon after the disappearance of the fiery circles, was heard a powerful noise, resembling the sound of wind, which went from north to south; the noise lasted about 5^m. Then followed sounds and crashes resembling the discharges of huge cannon, which made the windows rattle. These shots continued for 2^m and then was heard a crackling, resembling rifle shots. These latter continued for 2^m. All this happened when there was a clear sky."

4. At the Omoloyevsk meteorological station ($\phi = +56° 28'$; $\lambda = \text{E. } 106° 16'$) for the morning of June 30, 1908, is recorded "distant thunder."

5. At Shamansk, on the Angara ($\phi = +56° 58'$; $\lambda = \text{E. } 101° 47'$), the meteorological observer, V. V. Smirnov, recorded in the journal: "At $6^h 50^m$ A.M., the sky being perfectly clear and the weather calm, there was heard near the village Shamansk, in the air, at first a dull noise like the rumble of thunder, then crashing claps resembling cannon shots, about 30 in number; the phenomenon continued until $7^h 10^m$ A.M."

In regard to these observations, it must be pointed out that the conception of a "minute" is very vague in the minds of the common people, and the author, who has collected about 300 observations on different bolides in the U.S.S.R., can contend with assurance that it signifies usually a period considerably shorter. As has

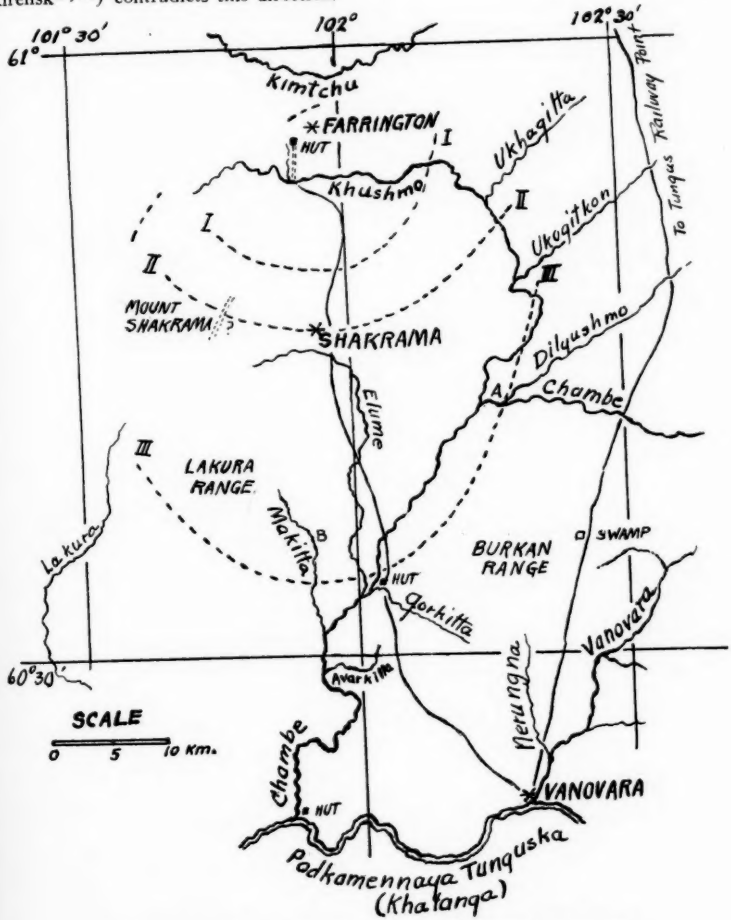
already been pointed out by A. Voznessensky and S. Obruchev (*loc. cit.*), the estimates of the moments of occurrence of any phenomenon are very rough under the conditions of life in remote localities, and frequently mistakes of from one to two hours(!) are possible, as is shown, *e.g.*, by the study of reports on earthquakes. The author used the barograms recording the passing of the air-wave caused by the fall of the meteorite of June 30, 1908, and arrived at a correction of the clocks of the meteorological stations in eastern Siberia that sometimes exceeded one-half hour (see hereafter).

6. A. Voznessensky had the kindness to put several new, unpublished observations at the author's disposal: G. N. Konovalov, physician, reports that K. I. Auerbach, "traveling through the Enisseysk district, noticed on the morning of June 17 (30), a shock and a noise resembling a distant explosion." The peasant, D. F. Kovykin, station Kimiltey, Siberian Railroad, writes: "According to rumor, two villages on the Oka river, about 100 versts from the village Uyan, Nizhne-Udinsk district, were destroyed"; at the station Sheragul, Nizhne-Udinsk district, "the earthquake was accompanied by a very distant rumble from the southeast and lasted no more than 2^m; on account of its unexpectedness, one had a feeling that the ground under his feet and around him rose and immediately fell; the horizon was clear, there was not one little cloud in the sky; no swinging or destruction of objects occurred." These statements were gathered by Simagin by means of questioning, and the date is recorded, probably erroneously, as June 16 (O.S. calendar), at 5 A.M., since, at that moment, according to the data of seismic stations, there was no earthquake.

7. A. Voznessensky reports[15] that, according to N. Poluzhinsky (Ilimsk meteorological station), "during the thunder one middle-class citizen of the town Ilimsk was some 4 versts from Ilimsk, up the river Ilim, and saw a 'flying star' with a fiery tail, which fell into the water, and its tail disappeared in the air." In October, 1931, the author visited this place and found that the indicated direction corresponds to the west; the meteorite disappeared behind the distant right bank of the Ilim river; by the "tail" one must understand the whitish wake [or train] remaining usually behind rapid bolides, which consists, as is well known, of ionized air and the products of the sublimation of the meteorite, illuminated by the rays of the Sun.[III, IV] Concerning the fact that the meteorite left a train behind it, we have the observations of E. Sarychev (L. Kulik[19]), I. Kokorin,[19] G. Kulesh (A. Voznessensky[15]), and the inhabitants of Nizhne-Korelinsk; also Vakulin and others.

8. The information obtained by the author (in 1930-32) from 27 of the 61 localities mentioned by A. V. Voznessensky,[15] permits us to establish beyond doubt that the meteorite became incandescent somewhere south of the Siberian railroad, flew over the Kansk region along a very sloping trajectory, then over Kezhma, where it crossed the Angara, and fell in the region described previously. At the present time, there is no reason to suppose that the meteorite flew out beyond the limits of the Earth's atmosphere[59] along an hyperbolic trajectory warped by the resistance of the air [and] passing through perigee at Khatanga. The new information [just presented] confirms the published data in regard to the fact that the meteorite "flew in the general direction from south to north" (L. Kulik[19]), from south-southwest to north-northeast (A. Voznessensky and the testimony of eyewitnesses); this fact is borne out also by the direction of the folds of surface turf[19] and the geographic distribution of observers of the flight of the meteorite (it was not seen at those western points where it would have had to pass near the

Sun), *etc.* This circumstance also accounts for the very high geocentric velocity of its [the meteorite's] motion through the atmosphere, noted by all the eye-witnesses, since, in such a case, the radiant would have had to lie near the apex of the Earth. Only one unreliable observation (from the village Voroninaya, near Kirensk[15, 28]) contradicts this direction.



MAP OF THE REGION OF FALL OF THE TUNGUS METEORITE, BASED ON MAPS PREPARED BY ASTAPOWITSCH

The contours I, II, III delimit, respectively, the areas in which: (I) the forest was uprooted and burnt by the action of the hot explosive waves; (II) trees were felled by the air-wave (radius about 20 km.); (III) trees were uprooted, chiefly on high ground. The stars indicate astro-radio points determined in 1929. *A* and *B* mark the position of nomad camps in 1908.

§3. *An Itinerary Survey in the Region of the Fall.*—A. Ovchinnikov (Geophysical Institute of the G.M.K. of Eastern Siberia, Irkutsk), being in the region of the fall of the meteorite in August, 1932, made an itinerary survey from Vanovara to "Kulik's Farm," which is near the center of the wind-fallen trees. Three astronomical points were determined by the meteorite expedition of 1929 (the trading station Vanovara, the mountain Shakrama, and the mountain Farrington); to these the author attached Ovchinnikov's survey; on this basis were plotted the data of all published material accessible to the author, and, at the present time, the collated map (*q.v.*), one may assume, deviates least from reality, even though it be crude. On the map were plotted the limits of the region in which the trees were partially felled by the wind blast, the probable limits within which the trees were totally felled by the wind, and, with lesser certainty, the probable limits of wholesale scorching. These three regions turn out to be situated concentrically; this fact points to a radially-acting force; in the opinion of the author, the explosion at the [time of the] fall of the meteorite was due to the transformation of kinetic energy of the order of 10^{21} ergs (according to I. Astapowitsch), and 3.2×10^{20} ergs (according to Whipple[50]), into other forms of energy. It was this explosion that gave rise to the seismic- and air-waves, while the high-temperature explosive wave caused the uniform scorching over the first few kms.; (in 1928 it was discovered that the scorching was more pronounced on that side of the tree-trunks which faced the center of the wind-fallen woods‖). The wave almost completely tore up the taiga near the place of the explosion, and, farther away, on unprotected spots (hilltops, *etc.*). In connection with this, sound-waves and infra-sound-waves arose; the former were noticed by observers at distances of several hundred km. and the latter were discovered by C. Cave in 1929 on microbarograms in England[50] and by the author in the U.S.S.R. (see hereafter).

S. Obruchev states that, according to one of the Tunguses, the region of the wind-fallen trees is circular in shape and that the trees were blown down in the direction toward the north; later investigations and the data of Ovchinnikov do not, however, confirm this direction, and, according to L. Kulik, as mentioned previously, the trees were blown down in the manner of a fan in relation to one of the plateaus of the mountain-range Lakura; the woods totally felled by wind extend over an area of radius 30 to 35 km.; those partially blown down extend over an area of radius 60 or 70 km.[58] According to S. Obruchev[16] and J. Suslov,[17] as well as [to] fragmentary information from V. Sytin,[24] N. Strukov,[36] and others, which is confirmed by new data from Ovchinnikov, we may consider the southern and eastern limits of the wind-fallen woods as fixed. The question concerning the western and northern limits must remain open until the publication of the results of the expeditions of the Academy of Sciences. Of especial interest is the location of the northern limit, in view of the fact that the meteorite flew in the direction of the meridian. The Tunguses[17] spoke of a "furrow," "a dry creek," [and], further, of three other holes previously unknown to them ("one large pit was discovered far from the stream Dilushmo, to the northeast, just this side of the summit of the Southern Chuni"; the other, "to the north of the range Lakura, between the rivers Kimchu and Khushmo, about midway between them"; and the third is indicated by J. Suslov, on the schematic map [as] at the end of the "furrow"). On the basis of all the data, the author considers it probable that the "dry

‖ "Fire swooped down and blew down the woods";[19] the Tungus Luchetkan [testified]: "It blew down the woods and burned everything";[1, 23] and [so did] many others.[20]

creek," and perhaps one of the pits were located on the range Shakrama, west of the astronomical point "Shakrama," determined by S. Y. Belykh in 1928 ($\phi = +60° 44'.3$; $\lambda = \text{E. } 101° 55'.3$), and west of the winding path from Vanovara to the center of the wind-fallen trees; that the second pit, from which "a spring rose," since the water-carrying sands described previously had been opened up, probably [by meteoritic impact], was in the region of the investigations made by the expeditions of the Academy of Sciences in 1927-29; and that the third pit, a very doubtful one, [was] some 60-70 km. east of the second; here no wind-fallen trees have been noted. These considerations will have to be checked by future research (see the figure).

§4. *Meteorological Conditions at the [Time of the] Fall of the Meteorite.*— With the aim of studying the general meteorological conditions at the time of the fall of the meteorite, the author, in 1932, collected the observations of meteorological stations that made observations in 1908 and are now included in the net of the G.M.K. of Siberia; Table 1 contains a list of these, their geographical coördinates, and excerpts from the observation journals.

TABLE 1

The pressure, temperature, cloudiness, direction, and strength of the wind on June 29-30, 1908, according to data of the meteorological stations in central Siberia.

No.	Place	ϕ (+), ° ,	λ (E.), ° ,	Pressure (in mm.) and $t°$ (7^h, June 30, 1908)		Cloudiness 21^h	7^h	13^h	— Wind — 21^h	7^h	13^h
1	Abakansky Factory	52 44	90 13	779.4	13.3	10	10	10	NW 1	0	W 1
2	Barguzin	53 07	109 38	768.0	16.4	5	0	1	NNE 3	WSW 5	0
3	Blagoveshchensky	58 10	114 19	773.0	13.4	8	8	9	0	0	N 3
4	Bratsk	56 04	101 56	767.6	15.3	0	0	6	0	0	0
5	Dudinka	69 23	86 04	757.2	20.6	10	10	1	0	0	0
6	Yenisseisk	58 17	92 10	766.5	23.2	2	2	0	ENE 3	ENE 2	ESE 4
7	Zima	53 55	102 03	772.0	22.8	5	0	7	0	0	S 4
8	Ilimsk	56 47	103 51	762.5	11.2	5	10	10	0	0	0
9	Irkutsk	52 16	104 19	771.0	15.2	10	2	2	ES 5	0	SW 1
10	Kamenka	58 37	95 40	....	18.0	0	0	0	N 1	NE 3	SE 1
11	Kansk	56 12	92 40	767.5	21.1	10	5	10	NNE 2	ESE 2	E 4
12	Kezhemskoye	58 58	101 04	....	18.5	3	4	10	NE 1	SW 3	E 1
13	Kirensk	57 47	108 07	759.1	15.7	7	0	9	0	0	N 2
14	Nizhne-Udinsk	54 55	99 03	757.9	16.2	0	0	0	0	0	E 3
15	Omoloy	56 28	106 16	767.	16.5	4	3	10	NNW 1	0	NNW 5
16	Solonetskoye	54 35	98 48	....	17.0	0	0	0	0	NW 2	NE 3
17	Tayshet	55 54	97 30	751.5	19.5	1	2	2	0	0	E 4
18	Tulun	54 33	100 22	757.2	17.8	0	0	0	0	0	SE 4
19	Turukhansk	65 55	87 36	763.0	23.6	3	2	3	N 1	NNE 3	NNW 5
20	Usolye	52 44	103 42	765.1	17.4	0	0	0	0	0	NE 1
21	Khatanga	71 59	102 20	....	16.3	10	10	10	W 3	WSW 5	WSW 4
22	Shamanskoye	56 58	101 54	762.0	16.0	0	0	0	0	0	SE 3

The author has reduced the pressure to sea-level, inserting the mark (?) where the elevation of the point above sea-level was not sufficiently certain. The temperature is given in terms of the dry thermometer at 7^h A.M. [The time used appears to be local; however, if the Russian Meteorological Service follows the same practice as that in the United States, the time may be that of the 105°-meridian east of Greenwich]; the cloudiness is given according to the usual 10-point scale for 21^h, June 29, 7^h and 13^h, June 30, 1908; likewise the rhumbs of wind, the numbers indicating the velocity in meters per second. An examination of these

data shows that throughout nearly the whole region of observation the weather was anti-cyclonic, and only in the northern part (Dudinka, Khatanga) was it cloudy; unfortunately, the lack of observations between the parallels of 60° and 70° renders it impossible to determine exactly the boundaries of cloudiness. Thus, the meteorological data well confirm the reports of eyewitnesses of clear and calm weather during the flight of the meteorite, which favored its observation. With this fact vanishes every doubt that the whirlwind personally experienced by S. Semenov,[20] the Tungus Ivan Potapovich,[19, 16] his wife Akulina Machakugyr and family,[16, 17, 11] by Basil Okhchenoy,[17] by sons of the Tungus Podyga, Chekaren, Chuchancha, and Nalega,[17, 12] and possibly by others, was occasioned by the meteorite and not [by] an ordinary windstorm.[37]

§5. *Atmospheric Phenomena at the Fall of the Meteorite.*—The aërial shocks observed at Kezhma, Nizhne-Ilimsk, Kirensk,[15] and a number of other places,[8, 19] were connected with the development of groups of waves of different frequencies (see hereafter), and were recorded by all barographs of central Siberia. Apparently there are indications of the effects of a ballistic whirl caused by the meteorite's flying relatively low over the surface of the Earth, although the basic effects were due to the previously-mentioned explosive-wave. Similar phenomena have been observed not infrequently in connection with the falls of other meteorites (in the U.S.S.R., *e.g.*, the Kashinsky [= Glasatovo, Kashin, Tver Govt.] meteorite of 1918, of which the head wave damaged the roofs and chimneys of houses and broke the branches of trees). The explosion with which the flight of the meteorite ended was observed 450 km. away, at Kirensk (Kulesh[15]), Nizhne-Korelinsk (480 km.), Nizhne-Ilimsk (400 km., Vakulin, N. Ponomarev), with especial force at Vanovara (S. Semenov,[20] P. Kosolapov), 65 km. in a straight line to the south-southeast of the center of the explosion, and by the Tunguses; the latter camp during the summer on elevated places where there are fewer mosquitoes to annoy the reindeer; hence they suffered considerably.

It had been mentioned in the literature[15] that at Kirensk the air-wave was registered on the barograph, its amplitude, according to the author's measurements in the latter part of 1932, proving to be 1.4 mm. at $7^h\,48^m$ A.M., or $0^h\,36^m$ G.M.T.; this fact led the author to examine the barograms of other stations. In 1932, thanks to the coöperation of Ovchinnikov (Irkutsk Geophysical Institute of the G.M.K.), this material was obtained; in addition, A. A. Treskov (Irkutsk Seismic Station of the Academy of Sciences) kindly put at our disposal his own data, which show that B. Shostakovich also worked on this problem, in 1930. This material consisted of tapes of self-recording barographs (mainly Naudet and Richard) from the present meteorological stations of eastern Siberia, from a section of the Yakutsk S.S.R., from a section of west Siberia, and from the Buriat-Mongolian A.S.S.R. The most distant points were Chita and Khatanga (more than 1100 km. from the place of fall), Sretensk (over 1200 km.), and Verkhoyansk (1680 km.). In 1933, the same sort of wave was found by the author on the tape of the Sprung mercury-microbarograph at Slutsk, near Leningrad, which was confirmed by the Hassler barogram (at the same place), and was recorded, with a barely noticeable amplitude of 0.2 mm., even by the 48-hour Reinacher barograph (Leningrad Meteorological Station).

In England, Cave found a record in Petersfield, [and] five more in Kensington, Westminster, London, Cambridge, and Reading. These furnished Whipple with the material for his well-known work.[50] Undoubtedly all these data constitute only a fraction of the still uninvestigated material of the automatic recorders of

the U.S.S.R. and other countries. Following are listed the results of the barograms examined; as has been stated, they were taken from the Naudet and Richard recorders, whose vertical scale is 1 mm. del. = 1 mm. of pressure, the apparatus being wound weekly in such fashion that 1 mm. in the horizontal [direction] corresponds approximately to $0^h6 = 36^m$. Three times daily, at 7^h, 13^h, and 21^h, the meteorological observers make recordings; with reference to these, the position of the line caused by the passage of the air-wave was measured. On account of the minute scale, the records reveal no details (see Fig. 2 [omitted here]), with the exception of the barogram from Kultuk (see hereafter). In Table 2, t denotes the moment of the arrival of the sound-wave, according to local time, and A its amplitude in mm. (from maximum to minimum).

TABLE 2

The moment of the arrival of the air-wave and the amplitude of oscillation, according to barograms of stations in central Siberia, June 30, 1908.

No.	Place	ϕ(+) ° ′	λ(E.) ° ′	t h m	A mm.	Remarks
1	Tulun	53 33	100 22	8 08	2.45	Good record.
2	Kirensk	57 47	108 07	7 48	1.10	Good record.
3	Dudinka	69 23	86 04	?	?	Very poor record.
4	Turukhansk	65 55	87 36	6 44	0.90	Ditto; the wave is distinct.
5	Krasnoyarsk	56 01	92 51	?	0.15?	Wave doubtful.
6	Goloustnaya	52 01	105 27	?	0.42?	
7	Khatanga	71 59	102 20	8 02	1.10	Record poor, wave distinct.
8	Olkhon	53 03	106 54	8 17	1.50	Wave barely noticeable.
9	Perevalnaya	51 44	112 37	8 18	0.05	Very doubtful wave.
10	Irkutsk	52 16	104 19	7 29	1.65	Good record.
11	Sretensk	52 14	117 42	7 30	1.60	Good record.
12	Nerchinsky Factory	51 19	119 37	—	—	Pen was pressed down too much.
13	Troitskosavsk	52 21	106 27	8 34	0.10	Very doubtful.
14	Chita	52 02	113 30	8 22	0.40	Record poor; wave distinct.
15	Tunka	51 45	102 32	7 58	1.45	Wave distinct.
16	Mysovaya	51 43	105 52	7 29	0.20	Very doubtful.
17	Kultuk	51 43	103 44	8 12	0.55	Wave distinct.
18	Kabansk	52 03	106 39	8 22	1.20	Wave distinct.
19	Peschanaya Bukhta	52 15	105 43	7 57	1.00	Wave distinct.
20	Petrovsky Factory	54 17	108 51	—	—	Record good, no wave.
21	Dagarsky Mayak	55 42	109 53	No barogram.		——
22	Minusinsk	53 43	91 41	No barogram.		——

[*To be continued.*]

VARIABLE STARS

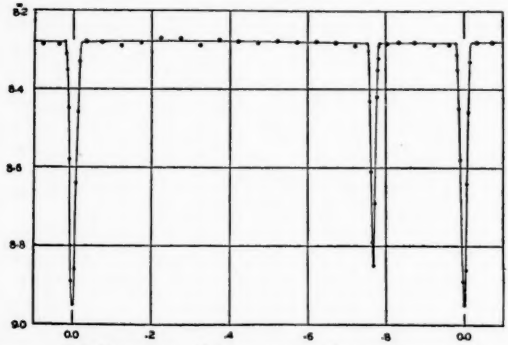
Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

DI Herculis; Eclipsing Variable with Orbit of Large Eccentricity: When the complete light curve of the eclipsing binary DI Herculis is plotted, Dr. L. Jacchia finds that the displacement of the secondary minimum is uncommonly large. The interval from primary to secondary is 8.1 days, while that from secondary to pri-

mary is only 2.4 days, a ratio of more than three to one. The duration of the two eclipses is also somewhat different, the primary lasts 0.42 day while the secondary lasts only 0.32 day, which indicates that at the time of the secondary eclipse the two components are much closer together in the eccentric orbit than during primary eclipse.

The eccentricity, 0.47, is extremely high, exceeded only, perhaps, by two, HV 7498 and V 384 Centauri (0.50). During the forty-one years covered by the observations made from Harvard plates, Dr. Jacchia finds no appreciable change in position of the secondary minimum relative to the primary, that is no measurable apsidal motion, which may be accounted for by the particular position of the line of apsides during those years and by the extreme distance between the two components, which averages 17 times their radii.



DI HERCULIS: PHOTOGRAPHIC LIGHT CURVE.

A Cepheid Variable with an Anomalous Period: Dr. Jacchia, in a recent *Harvard Bulletin,* calls attention to the fact that the Cepheid variable BL Herculis has a period quite unusual for the form of its light curve. With a period of about one and a third days (1.307472 days)—at the place on the frequency curve of periods of Cepheid variables where there are relatively few known—the light curve resembles that of a Cepheid with a long period. For galactic Cepheids with periods between 0.85 day and 1.50 days there are only five recorded.

The photographic and visual curve, both observed by Dr. Jacchia, have the same general form, although there is the customary color-index difference.

The Photographic Light Curve of RS Ophiuchi, 1933: The second outburst of RS Ophiuchi, which occurred in 1933, has been observed by Miss Pearl Rubenstein from Harvard photographs and recently discussed by Dr. R. Prager. Fortunately, two plates taken on August 11, 1933, two hours and twenty-one minutes apart, were secured when the nova was increasing in brightness and indicated a change in magnitude from 8.92 to 6.86, showing how rapid is the development of such an outburst just before maximum light has been attained.

The accordance between the photographic and visual light curve is excellent. The two curves coincide remarkably well when an adjustment of about one magnitude is made. The photographic curve is fainter than the visual curve by this amount. As has been previously noted, the 1898 light curve of RS Ophiuchi can be considered as almost an exact counterpart of the 1933 light curve, if we suppose the 1898 maximum as having been reached on June 17, and probably it was about

as bright as that of 1933, when it attained the visual magnitude of 4.3. The star was practically back to normal minimum by the winter of 1934.

Peculiar Variables: All four of the best observed R Coronae Borealis-type variables are now at normal maximum brightness; R Coronae Borealis at the sixth magnitude; SU Tauri, slightly brighter than the tenth; S Apodis, almost exactly at the tenth; and RY Sagittarii, between the sixth and seventh magnitudes.

S Apodis has been at maximum, with little if any deviation from magnitude 10.0, since August, 1935. It should be carefully watched by southern observers in order that a sudden drop to minimum may not escape attention.

Although R Coronae Borealis and RY Sagittarii have recently regained their full brightness, they should not be relegated to the inactive list for one can never tell when they may fade away again. Then, too, the short term periodicity detected by Dr. Jacchia for RY Sagittarii should not be forgotten. All four of these peculiar variables require constant vigilance.

Z Andromedae, frequently referred to as a nova-like variable, has slowly decreased to the tenth magnitude—September 1—after having been at maximum, magnitude 7.9, in October, 1939. Between June 1 and October 1, 1939, the variable increased from magnitude 10.5 to 7.9.

Variable Stars at the American Astronomical Society Meeting: At the meeting of the American Astronomical Society held at Wellesley College, September 11 to 14, of the 42 papers presented, 14 dealt, directly or indirectly, with variable stars. Six of these pertained to the problem of eclipsing variables while three referred to progress in general variable star studies.

Philip Taylor referred to the peculiar variable EZ Aquilae for which a period of 38 days has been derived and which displays many of the features found in the now well-known variable DF Cygni. He preferred, however, to classify EZ Aquilae as a Cepheid-type variable rather than as an RV Tauri-type star.

Mrs. Emily H. Boyce reported on a study of variables found in a survey of a high galactic field at $16^h\,20^m$, $-5°$, in which 140 variables are known to exist. Of particular interest was her report on the recent variation of X Serpentis, a nova which appeared bright, at ninth magnitude, in 1903. Since 1935 the star has shown somewhat regular variation, in a mean period of 275 days, not unlike these variations found in Z Andromedae and AX Persei, and possibly, also, Nova (RS) Ophiuchi.

Helen B. Sawyer reported on her studies of variables in the much neglected Herculis Cluster, Messier 13, in which very few variables have been found to date. Only eleven variables have been detected in this cluster. Variable number one, for which a period of 6.0 days had been ascribed, is now known to have a period of only 1.45899 days, a value more in keeping with what one should expect from the period-luminosity relation for a variable of its magnitude.

Variables in another cluster, Messier 15 in Pegasus, were described by Miss Helen W. Dodson, when she recounted the progress of the work done on these stars at Wellesley during the past few years. Periods for all but five of the cluster-type variables have been derived and only one of them was found to belong to the long-period Cepheid class. Most of the periods were between $0^d.35$ and $0^d.6$.

S. Gaposchkin read three papers, one of which dealt with the progress of variable star studies by the Harvard Milton Bureau. Some two thousand variables are under investigation from Harvard plates and any one particular variable will, in general, be found on from 1200 to 1500 plates. It is expected that when the task is completed approximately three million observations will have been secured.

The two additional papers reported by S. Gaposchkin concerned two interesting binaries. RY Persei and the Wolf-Rayet HV 11111. The former variable has a period of $6^d.87$ and the spectrum consists of a B6 component and an F8. No orbital velocities have ever been published for either component. A photographic light curve has been derived from 4770 observations. The photographic range of primary and secondary minima are $2^M.01$ and $0^M.01$, respectively, and the eclipse is total. The larger and fainter component has a luminosity and mass almost identical with those of the brighter component of Capella. There is a suggestion of a fluctuation of the time of primary minimum over a period of nineteen years and an unusually small semi-amplitude of thirty minutes of time, which corresponds to 0.003 of the period of eclipse.

The Wolf-Rayet star is the first which has been shown to be an eclipsing variable, although it was found to be a spectroscopic binary by O. C. Wilson. The Harvard plates reveal the star as an eclipsing binary with a period of $4^d.21238$, a range of primary minimum from $8^M.4$ to $8^M.7$, and of secondary, for $8^M.4$ to $8^M.5$. The Wolf-Rayet component of the system is, contrary to expectations, considerably fainter than the B1 component. The most probable radii are, for the Wolf-Rayet star, 0.27 A (9.70), the respective masses are 10.2 and 25.9 suns, and the absolute visual magnitudes, $-1^M.6$ and $-3^M.5$.

The paper by T. E. Sterne dealt with the sources of spurious eccentricity in spectroscopic binaries. He showed that the surface of a tidally distorted star is not uniformly bright; those portions closest to the star's center are the brightest. The rotation of the tidally distorted star, having such a variation of surface brightness, introduces terms in the radial velocity of a component of a spectroscopic binary. Even if the geometrical orbit is really circular, the terms in question, if not allowed for, lead to a non-vanishing orbital eccentricity. In such a case the photometrically determined zero eccentricity (if eclipses are observed) is correct and the spectroscopic value is spurious.

Newton L. Pierce reported on the eclipsing variable RW Geminorum for which there appears to be no variation in the length of the assigned period. This result, in view of the fact that recently many eclipsing binaries have shown signs of changes in periods, is of considerable interest.

B. W. Sitterly discussed at some length the effects of "gravity darkening" upon the light curve of close eclipsing binaries, a field of investigation which had already been touched upon by T. E. Sterne in his paper mentioned above.

The interpretation of Beta Lyrae—long an enigma—by G. P. Kuiper was perhaps the most spectacular of the papers on variable stars. He pictured the two components of Beta Lyrae as in actual contact, perhaps even fused together, with one somewhat larger than the other and with a circulation of gaseous matter from the larger star enveloping the smaller star. Both stars could be surrounded by a greatly extended atmosphere with material flowing from one to the other so rapidly that some of it is actually ejected from the smaller component so as to form a dragging tail.

Dean B. McLaughlin told more about novae, especially of the changes in spectrum near the time of maximum light. As far as there is evidence, the spectral type of the bright nova changes to a slightly later type as maximum is approached and passed. Although few spectra have been obtained of novae prior to maximum phase, those few which have been secured indicate an earlier type of spectral class than is found after maximum has passed. For the recurrent novae, such as T Pyxidis, the pre-outburst spectrum is considered to be not unlike the "old nova" spectrum.

A paper by C. T. Elvey and H. W. Babcock on the spectrum of Z Camelopardalis and other U Geminorum-type stars described the spectral differences of these peculiar stars at minimum and maximum, and in between. A preliminary survey indicates that this group of variable stars will not fit into the general scheme of classification but instead should be provisionally treated as a special group in the spectral classes. The authors find that at or near maximum light the stars observed show essentially a continuous spectrum with some of them having wide, diffuse, and weak absorption lines of hydrogen. As the star begins to decrease in light the Balmer emission lines or bands begin to appear, and, at about the same time, a wide emission line or band of He II at λ 4686. At minimum brightness the continuous spectrum has become distinctly redder, with the emission spectrum superimposed. During the minimum phase of these stars it is found that there is very little alteration in spectrum, as far as the few photographs now available can indicate.

A tabulation of a number of hydrogen emission lines visible as the star is on the increase, decrease, and at minimum and maximum, shows that several lines are visible on the increase, few, if any, at maximum, more on the decrease, and still more at actual minimum. During the peculiar stage of RX Andromedae when the star remains at nearly constant brightness, about midway between maximum and minimum, some six weak, emission lines of hydrogen are observed.

It was found, for SS Cygni at least, that the radial velocity at the center of the emission lines about a month preceding a particular maximum, October, 1939, was —60 kilometers per second, while a spectrogram taken after the star had begun to brighten revealed a velocity of +95 kilometers per second.

A paper by Charles Hetzler of Dearborn Observatory on "Infra-Red Magnitudes and Indices of Dearborn Stars" was read by title only.

Raymond S. Dugan: Variable star astronomy lost an incomparable observer when Dr. Raymond S. Dugan of Princeton Observatory died on August 31. For more than a quarter of a century Dr. Dugan had been an indefatigable observer of eclipsing variables. With a polarizing photometer he had determined the light curves of many of these stars, with a total of measures which far exceeded those made by any contemporary observer. Princeton publications attest the accuracy of the observations and the completeness of the discussions which he made of them. The A.A.V.S.O. was proud to have him enrolled as one of its honorary members.

Observers and Observations received during July and August, 1940:

Name	July Var.	July Obs.	August Var.	August Obs.	Name	July Var.	July Obs.	August Var.	August Obs.
Albrecht	10	15	8	11	Chandra	..	..	156	256
Baldwin	..	..	56	78	Chilton	8	8	11	11
Ball, A. R.	52	94	56	87	Christman	..	..	10	10
Ball, J.	17	17	33	39	Cilley	39	51	28	101
Bappu	28	41	..	..	Cousins	35	101	30	172
Bender	1	1	6	6	Dafter	9	31	9	33
Blunck	67	82	66	80	Diedrich	29	50	14	18
de Bois Blanc	2	2	8	8	Ensor	..	..	22	38
Bouton	27	27	33	36	Escalante	27	28	..	..
Britzelmayer	4	8	..	..	Ferguson	..	..	21	53
Brocchi	9	9	..	..	Fernald	63	74	105	202
Buckstaff	24	186	23	64	Ford	..	..	12	14
Callum	30	52	41	73	Forrester	6	6	10	17
Cameron	9	9	..	..	Franklin	17	21	15	15
Carpenter	9	9	..	..	Gomi	9	43	..	..

Name	July Var.	July Obs.	August Var.	August Obs.	Name	July Var.	July Obs.	August Var.	August Obs.
Gregory	58	77	59	100	Palo	20	25	32	57
Griffin	12	12	63	63	Parker	26	39	11	11
Halbach	50	79	41	44	Parsell	..	..	1	2
Harris	34	34	40	49	Peltier	42	125	65	159
Hart	..	..	5	5	Prinslow	5	6	14	14
Hartmann	57	60	110	139	Purdy	19	60	15	15
Heckenkamp	4	10	..	..	Reisner	5	5	..	..
Hiett	5	10	3	5	Rense	2	2	..	..
Holt	78	96	102	172	Rosebrugh	12	70	9	58
Houghton	81	113	..	..	de Santis	7	11	..	..
Houston	..	..	28	149	Saxon	40	53	33	35
Howarth	..	..	8	8	Schilke	2	2	..	..
Huffer	9	12	26	50	Schoenke	14	27	12	26
Irland	11	11	..	..	Schmid	22	34	20	24
Jones	61	256	38	121	Shafer	5	8	5	10
Kanda	3	21	..	..	Sill	29	29	31	32
Kearons	49	75	65	94	Smith, F. P.	4	4	9	9
Kelly	20	23	12	15	Snyder	2	2	2	4
de Kock	71	310	70	250	Stahr	..	..	2	4
Livingston	12	12	35	35	Taulman	..	..	9	9
Lovinus	8	9	11	13	Topham	27	30	93	93
Mages	20	29	..	..	Townsend	3	4	10	10
Mason	3	3	8	8	Walton	10	16	16	30
McKeon	..	..	3	3	Webb	15	15	13	13
McPherson	12	20	23	34	Weber	15	15	4	4
Meek	..	..	35	345	Whittier	12	12	..	..
Moore	9	9	9	10	Yamada	8	11	8	12
Murphy	..	..	7	7	Yamasaki	..	..	19	19
Nadeau	..	..	2	2					
Needham	4	4	35	35	(Totals)		2865		3843

September 17, 1940.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editor may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Solar System Symmetry

The uniformity of planetary distance intervals, shown by Kepler's arrangement of regular solids and by Bode's numerical series, has interested astronomers and students of Nature for nearly three centuries.

Recently similar regularity has been found to exist among the satellites of several planets. Up to the present time no accepted reason for these symmetrical relationships has been advanced. Nevertheless, evidence is emerging along several lines which seems to indicate that the phenomena may have a vibratory origin. It is commonly known that all rotating bodies are vibrators and the sun long has been recognized as a radiator of electromagnetic vibrations.

Planetary distance intervals follow a progression of the squares of simple numbers similar to those which characterize the line spectra of atoms, an electromagnetic or vibrational phenomenon. This progression was noted by Professor

Fernando Sanford of Stanford University and was published in POPULAR ASTRONOMY, June-July, No. 6, Vol. XXIX.

				+5	+5	+5	+5	+5
The squares of	3,	4,	5,	6,	11,	16,	21,	26,	31
i.e.,	9	16	25	36	121	256	441	676	961

when multiplied by appropriate length units (4 million miles or 6.4 million km.) are roughly the planetary mean distances from the sun.

Solar system periodicities also conform to a sesquiple (increasing by the factor 3/2) number series that is common to sound-wave vibrations as well as to sun and planets and planet-satellite systems:

2					
4	6				
8	12	18			
16	24	36	54		
32	48	72	108	162	
64	96	144	216	324	486

The basic numbers are products of the powers of 2 and 3. Arranged serially, numbers in successive columns are as sums of numbers in preceding columns. Numbers in the horizontal sequence correspond to vibration frequencies of the musical notes C, G, D, A, E, B, in that order.

Applied to the solar system, these numbers correspond to mean distances from the sun (in millions of miles) of planets and planetoids from Venus to Jupiter inclusive. The square roots of the distance numbers, taken in reverse order, (*i.e.,* 22, 18, 14.7, 12, 9.8, 8) are as planetary orbital velocities (in miles per second).

The serial distance numbers proceed outward with the ratio 3/2 (or proceed inward with the ratio 2/3). Extended outward, the number for Saturn is as the mean of the next two terms of the series ($\overline{729+1093}/2 = 910$); the number for Uranus is twice this mean (1820). The basic ratio, 3/2, is then applied to get the numbers for Neptune (2730) and Pluto (4096).

Proceeding inward, the number for Mercury is as the mean of the next two terms of the series ($\overline{42.8+28.4}/2 = 35.5$). Half this mean (17.7) would be the next inward number of a balanced series and the two next serial terms, with ratio 2/3, would be 11.9 and 7.9, respectively. The square roots of these interior numbers are as orbital velocities (in miles per second) of the outer planets, *i.e.,* Saturn 5.95, Uranus 4,2, Neptune 3.45, and Pluto 2.8.

Thus the sesquiple series as applied to the solar system is as follows:

Numbers:	7.9	11.9	17.7	35.5
Planets:				Mercury
Sq. roots:	2.8	3.5	4.2	5.95
Orb. Vel.	Pluto	Neptune	Uranus	Saturn

Numbers:	64	96	144	216	324	486
Planets:	Venus	Earth	Mars	Vesta	Ptd.	Jupiter
Sq. roots:	8	9.8	12	14.7	18	22
Orb. Vel.	Jupiter	Ptd.	Vesta	Mars	Earth	Venus

Numbers:	910	1820	2730	4096
Planets:	Saturn	Uranus	Neptune	Pluto
Sq. roots:	30			
Orb. vel.	Mercury			

It will be noted that the numbers are paired, *i.e.,* products of pairs are con-

stant, $(N_1 N_2 = K)$, *e.g.*,

Venus and Jupiter		Earth and Planetoid		Mars and Vesta
(64×486)	=	(96×324)	=	(144×216)

The importance of this relationship will appear later.

Through a simple formula involving the velocity of light, a series of planetary distance numbers can be derived which closely follows the harmonic series of sound-wave frequency numbers. The derived numbers not only show the familiar regular intervals, but from their derivation they suggest a connection with electromagnetic vibration. The formula is $cd/R = N$, where c is the distance light travels in one second, d is mean planetary distance measured in sun radii. R is radius of sun, and N is planetary number. *E.g.*, Earth (mile/second units):

$$186{,}000 \times 216/432{,}000 = 93.$$

The numbers are as follows:

Planet	Numbers derived through formula	Harmonic Wave serial numbers
Mercury	36	35.5
—	—	—
Venus	66	64
Earth	93	96
Mars	141	144
Vesta	...	216
Planetoid	...	324
Jupiter	483	486
—	—	—
Saturn	885	910
Uranus	1780	1820
Neptune	2850	2730
Pluto	3650	4096

The numbers multiplied by one million miles are planetary distances.

Cube roots of planetary periodic time in seconds correspond to a related series of harmonic sound-wave frequency numbers, thus connecting planetary periods, distances, and orbital velocities in a trilateral numerical pattern:

Planet	Sound wave series	Cube roots of periodic time
Mercury	192	197
—	—	—
Venus	256	268
Earth	324	316
Mars	384	390
Vesta	486	480
Planetoid	576	...
Jupiter	729	722
—	—	—
Saturn	972	975
Uranus	1380	1383
Neptune	1728	1735
Pluto	2048	2000

These numbers also are paired and the constant product of the paired serial numbers is 186,624, or about the velocity of light in miles per second. (This suggests its possibility that cube roots of planetary periodic time may be related to the vibration frequency of electromagnetic waves.)

It will be seen that a medial point in the solar system lies between Mars and Vesta; that is, the geometrical mean of the pairs is a number between the terms for Mars and Vesta.

It is found that the basic ratios of the planetary series are related to similar periodicities in planet-satellite systems and that similar serial numbers are applicable. As shown in the harmonic series, planets are paired, that is, products of distances, or periods, or velocities of pairs tend toward constant values, *e.g.*, (mile/second units):

Planets:	Mercury and Saturn	Constant	Venus and Jupiter
Distances:		(approx.)	
(approx.):	$(36 \times 10^6) \times (885 \times 10^6)$	$= 32 \times 10^{15} =$	$(66 \times 10^6) \times (483 \times 10^6)$
Periods:	$(7.6 \times 10^6) \times (928 \times 10^6)$	$= 71 \times 10^{14} =$	$(19.4 \times 10^6) \times (373 \times 10^6)$
Orb. vels.:	29.7×6	$= 178 =$	21.8×8.1

The square root of any of these products, *i.e.*, $(D_1 D_2)^{1/2}$ or $(P_1 P_2)^{1/2}$ or $(V_1 V_2)^{1/2}$, corresponds to a medial point in the solar system which lies between Mars and Vesta. Elements of a planet at this point would be (approximately): Distance, 179,000,000 miles; Periodic time, 85,000,000 sec.; Orbital velocity, 13.3 miles per second.

Similar medial points for planet-satellite systems can be found through simple formulae in which

L = planet's mean distance from sun in common length units.
l = satellite's mean distance from primary in common length units.
P = planet's periodic time in seconds.
p = satellite's periodic time in seconds.
V = planet's orbital velocity.
v = satellite's orbital velocity.
M = mass of sun.
m = mass of planet.

(1) $$\frac{(L_1 L_2)^{1/2}}{(M/m)^{2/3}} = (l_1 l_2)^{1/2} = l \quad \text{(Of body at medial point)}$$

(2) $$\left\{\frac{P_1 P_2}{M/m}\right\}^{1/2} = (p_1 p_2)^{1/2} = p \quad \text{“}$$

(3) $$\frac{(V_1 V_2)^{1/2}}{(M/m)^{1/6}} = (v_1 v_2)^{1/2} = v \quad \text{“}$$

Medial points for planet-satellite systems determined through the formulae are as follows in mile/second units (approximate):

Planet	Distance	Period	Orb. vel.
Mars	8,600	50,000	1.09
Jupiter	1,740,000	2,600,000	4.2
Saturn	770,000	1,400,000	3.5
Uranus	223,000	560,000	2.5

Paired satellites are found by application of appropriate ratios. The following data and tables are based on the formulae.

In the Uranian system the basic ratios are the same as those for the solar system and the paired serial numbers 12, 18, 27, 40, multiplied by a constant ($k = 10{,}000$ miles) are about as mean distances of satellites from Uranus.

Pairs	Ariel and Oberon	Umbriel and Titania
Distances (miles)	120,000 and 365,000	166,000 and 270,000
Orb. vel. (m.p.s.)	3.5 and 1.9	2.9 and 2.3
Per. time (seconds)	216,000 and 1,160,000	356,000 and 750,000

The distance ratio for the Martian pair is 2.5, orbital-velocity ratio 5/8, and periodic-time ratio 4. These ratios are somewhat greater than squares of solar-

system ratios.

Pair	Phobos and Deimos
Distances (miles)	5,800 and 14,600
Orb. vel. (m.p.s.)	1.33 and .84
Per. time (seconds)	27,000 and 109,000

The basic ratios for Jupiter's satellites are the same as those for the solar system (distance 1.5, orb. vel. 1/1.225, per. time 1.8375). Squared orbital velocities yield numbers similar to the planetary serial numbers and a series of such paired numbers can be used to show the regularity of distance intervals. The numbers used here, multiplied by a constant ($k = 10{,}000$ miles) are approximately as orbital radii. The letter Y is used in the table to denote permissible but unoccupied theoretical orbits.

JOVIAN SYSTEM

Theoretical orbital radii ($k = 10{,}000$ mi.)	Satellites	Distances (miles)	Orb. vels. (m.p.s.)	Cube roots of per. time (sec.)
12 k	Fifth	113,000	16.5	35
{ 18 } mean =				
{ 28 } 23 k	Io	260,000	11	53.5
42 k	Europa	417,000	8.6	67.5
64 k	Ganymede	660,000	6.85	85
96 k	Y_4		*(Y_3)	
144 k	Callisto	1,200,000	5.2	113
Medial point		1,740,000		
216	Y_2		*(Callisto)	
324	Y_3		*(Y_1)	
486	Y_4		*(Ganymede)	
729 k *(Europa)	VI and VII	7,300,000	2.1	282
{ 1100 } mean =				
{ 1700 } 1400 k	VIII and IX	14,600,000	1.45 *(Io)	400
2500	Y_5		*(Satellite V)	

*Pair with.

Basic ratios for Saturn's satellites are about as the square roots of those for the planetary system: distance $(1.5)^{1/2}$, orbital velocity $(1/1.225)^{1/2}$, and per. time $(1.8375)^{1/2}$.

Titan occupies the medial point and therefore is not paired. Its distance is about 760,000 miles from Saturn, orb. vel. about 3.5 m.p.s.

A paired number series is also used here to show uniform distance intervals. The numbers multiplied by a constant ($k = 10{,}000$ miles) are about as orbital radii. The letter Z is used to denote permissible but unoccupied theoretical orbits. Phoebe is paired with a theoretical body between Mimas and Saturn.

SATURNIAN SYSTEM

Theoretical orbital radii ($k = 10{,}000$ mi.)	Satellites	Distances (miles)	Orb. vels. (m.p.s.)	Cube roots of per. time (sec.)
12 k	Mimas	115,000	8.8	43.5
14.7 k	Enceladus	148,000	7.9	49
18 k	Tethys	183,000	7.1	54.5
22 k	Dione	230,000	6.3	61
28 k	Z_1		*(Iapetus)	
34 k	Rhea	330,000	5.25	73
42 k	Z_2		*(Z_6)	
52 k	Z_3		*(Z_5)	
64 k	Z_4		*(Hyperion)	

Theoretical orbital radii (k = 10,000 mi.)	Satellites	Distances (miles)	Orb. vels. (m.p.s.)	Cube roots of per. time (sec.)
78 k (medial)	Titan	760,000	3.5	113.5
96 k	Hyperion	930,000	3.14	122.5
117	Z_8		*(Z_3)	
144	Z_6		*(Z_2)	
176	Z_7		*(Rhea)	
216 k	Iapetus	2,200,000	2	190
264	Z_5		*(Dione)	
324	Z_9		*(Tethys)	
400	Z_{10}		*(Enceladus)	
486	Z_{11}		*(Mimas)	
...				
...				
800	Phoebe	8,000,000	1.06	362

*Pair with.

Graphs of planetary orbits and of the Kennelly-Heaviside radio zones resemble graphs of the rings or zones which surround wires carrying electricity. Rotating suns and planets may generate such symmetrical zones and the motions of satellites may be regulated by electromagnetic waves radiated by the primaries.

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General Notes

The editor, with his family, returned home recently from a tour of four weeks through the Middle Western and Eastern States. His itinerary was planned to include as many astronomical centers as possible. Consequently he was able to visit sixteen observatories, four planetariums, four scientific museums, numerous colleges and universities, and to attend the September meeting of the American Astronomical Society at Wellesley College.

The cordial welcome shown and the many courtesies extended convinced him more than ever that, although without formal organization, there exists a real astronomical fraternity whose bond is a common interest in the pursuit of truth, and whose members also find time for friendly interchange of ideas and for the enjoyment of good fellowship.

The editor hereby expresses his thanks to all who so kindly opened their doors to him.

Dr. Raymond S. Dugan, professor of astronomy at Princeton University, authority upon variable stars, formerly secretary of the American Astronomical Society, died at the Bryn Mawr Hospital in Philadelphia on August 31. The funeral was held from his home in Princeton on Tuesday, September 3. A biographical sketch will appear in the succeeding issue.

James Stokley, who had been a member of Science Service until 1931, when he accepted a position with the Franklin Institute, Philadelphia, later becoming director of the Buhl Planetarium, Pittsburgh, has rejoined the Service. He will take the place of Robert D. Potter, staff writer in the physical sciences, who re-

signed on July 1 to become science editor of The American Weekly (*Science*, July 26, 1940.)

Robert D. Potter, formerly News Editor, Science Service and Science Editor, New York Herald Tribune, has joined the staff of The American Weekly as Science Editor.

William Stevens Buttles, an engineer specializing in metallurgy and interested in promoting amateur work in astronomy, died at the Billings Memorial Hospital on September 2, 1940.

Professor Hans Rosenberg died on July 25 according to word which has come from Istanbul, Turkey. Dr. Rosenberg was a Visiting Professor at the Yerkes Observatory from 1934 to 1936. His astronomical work was started at his private observatory in Tuebingen, Germany. After the war he became the director of the University Observatory at Kiel, a position which he lost in consequence of the discriminatory laws against non-Aryans. He was invited by the University of Chicago to come to the Yerkes Observatory where he was engaged in photometric studies of variable stars. In 1937 he was appointed director of the University Observatory at Istanbul and the last few years of his life were spent in the Turkish capital.

Professor Rosenberg was one of the first astronomers to use photoelectric methods for the determination of stellar magnitudes. His spectrophotometric observations of the energy curves of stars are among the most important publications in astrophysics.

Replicas of Giant Goose Lake Meteorite Distributed

The giant Goose Lake Meteorite, weight 2,573 pounds, which was recovered in California last May, has been the center of interest to thousands who have visited the University of California Astronomy Exhibit at the two sessions of the World's Fair on Treasure Island, San Francisco Bay. It will soon be moved to the U. S. National Museum in Washington, D. C.

To perpetuate the interest in its discovery, Professor Earle G. Linsley of Chabot Observatory, through the assistance of the skilled technicians of the Academy of Sciences in San Francisco, the courtesy of Dr. Robert C. Miller, Director, and the Smithsonian Institution to whom it belongs, has donated full size, very exact models to the Academy of Sciences, the Griffith Observatory in Los Angeles, and the Chabot Observatory.

In making these models the meteorite was hollow-cast in superimposed layers of plaster and burlap, made in two pieces that were afterwards joined together. A few years ago it would have been impossible to make these casts, as the surface irregularities and deep cavities of the meteorite precluded use of the ordinary plaster or gelatin mold. However, by the application of a number of layers of latex over the surface and into the cavities, a flexible mold was made, which was then reinforced with plaster, burlap, and clay. The completed casts were given a general stain, and then carefully colored with powder colors and shellac. Care was taken even to reproduce the lichens which had grown in spots on the upper or exposed surface of the meteorite.

Natural History Index-Guide

Widely scattered in the books and periodicals of the average library are over 2,000 articles on the geography of Africa, over 10,000 dealing with birds, 2,300 on flowers, etc. The difficult problem of immediately locating them is now solved with the publication of the "Natural History Index-Guide (H. W. Wilson Co., 950-72 University Avenue, New York. 583 pp. Service basis).

This valuable tool indexes 3,365 books and periodicals for the field of natural history in its broadest definition. In all there are 54,063 references to the indexed publications. These are entered under 9,477 subject headings. These headings appear in one alphabetical index with reference to material in fifteen major sections: Astronomy, Atmosphere, Botany, Food and Drink, Geography, Geology, Hygiene and Health, Microscopy, Paleontology, Zoology, etc. Consistent with accessibility, the best information obtainable is referred to for descriptions of the most interesting common things found in the forests, fields, waters, in the earth, in the skies, in the air, and in human life, as offered in the library records of natural history.

Brent Altsheler, the compiler, was assisted by an unusually able list of collaborators including nine divisional curators of the United States National Museum, three members of the Smithsonian Institution, and staff members of the Library of Congress, American Geographic Society, and the United States Department of Agriculture. Mr. Altsheler has devoted many years to his work. In 1936 he published a much less comprehensive guide in the field which, brought up-to-date, served as a beginning for this larger work.

Registration of Aliens

[*Even though the following is not of scientific interest in a restricted sense, we are, nevertheless willing to devote such space as may be necessary to aid in the dissemination of this information at a time when the National Defense program is of vital concern to all citizens.* EDITOR.]

As part of the National Defense program, a nationwide registration of aliens will be conducted from August 27 through December 26, 1940, by the Immigration and Naturalization Service of the Department of Justice. Registration will take place in the post offices of the nation. It is expected that more than three and one-half million aliens will be registered during the four-month period.

Registration is made compulsory by a specific act of Congress, the Alien Registration Act of 1940, which requires all non-citizens to register during the four-month official registration period. The law requires that all aliens 14 years or older are to be registered and fingerprinted. Alien children under 14 years of age will be registered by their parents or guardians. When alien children reach their fourteenth birthday, they will be required to register in person and be fingerprinted.

A fine of $1,000 and imprisonment of six months is prescribed by the Alien Registration Act for failure to register, for refusal to be fingerprinted, or for making registration statements known to be false.

As part of its educational program to acquaint non-citizens with the registration requirements, the Alien Registration Division is distributing more than five million specimen forms listing the questions that will be asked of aliens at registration time. Besides the usual questions for establishing identification, the questionnaire asks the alien to tell how and when he entered the country, the method of transportation he used to get here, the name of the vessel on which he arrived.

He is also asked to state the length of time he has been in this country and the length of time he expects to stay. He must also describe any military or naval

service he has had, and list the names of any organizations, clubs, or societies in which he participates or holds membership. In addition, he is required to describe his activities in any organizaton, and to affirm whether or not the organzation furthers the interests or program of a foreign government.

To make their registration easier, aliens are being asked to fill out sample forms, which will be available prior to registration, and take them to post offices where they will be registered and fingerprinted. Every registered alien will receive by mail a receipt card which serves as evidence of his registration. Following registration, the Act requires all aliens, as well as parents or guardians of alien children, to report changes of residence address within five days of the change.

The Alien Registration Act was passed so that the United States Government may determine exactly how many aliens there are, who they are, and where they are. Both President Roosevelt and Solicitor General Biddle have pointed out that registration and fingerprinting will not be harmful to law-abiding aliens. The Act provides that all records be kept secret and confidential. They will be available only to persons approved by the Attorney General of the United States.

Fingerprinting of aliens carries no stigma whatsoever. Thousands of citizens are voluntarily fingerprinted every year. Members of the United States Army and Navy are all fingerprinted, as are many Government workers. In recent years, many hospitals have established the practice of taking footprints of newly-born babies. Because fingerprinting is the only infallible method of accurate identification, the United States Government has adopted it as part of its registration program.

In signing the Alien Registration Act, President Rosevelt said, "The Alien Registration Act of 1940 . . . should be interpreted and administered as a program designed not only for the protection of the country but also for the protection of the loyal aliens who are its guests. The registration . . . does not carry with it any stigma or implication of hostility towards those who, while they may not be citizens, are loyal to this country and its institutions. Most of the aliens in this country are people who came here because they believed and had faith in the principles of American democracy, and they are entitled to and must receive full protection of the law."

Solicitor General Biddle adds, "We should remember that all Americans were at one time or another immigrants from other lands. The genius of many countries, the ancient aspirations of many races, have built into what is America. Unfortunately, there are some foreigners who are disloyal to America, who do not wish to accept our ways and who use our freedom of speech and of the press to foment disunity and sedition.

"These persons we will apprehend, but we will also see to it that loyal American aliens are not unjustly condemned for the disloyal behavior of a few. Our registration will be their protection from persecution."

The Immigration and Naturalization Service asks for the coöperation of all citizens in carrying out the Alien Registration program in a friendly manner so that our large foreign population is not antagonized. It is suggested that citizens may be of great help to their non-citizen neighbors or relatives by explaining to those who do not speak English well what the registration is, where aliens go to register, and what information they must give.

The Registration of Aliens program has been set up as a separate division of the Immigration and Naturalization Service. The program is being directed by Earl G. Harrison, under the general supervision of Major L. B. Schofield, Special Assistant to the Attorney General.